# EFFECTS OF HABITAT MODIFICATION ON THE PARASITE COMMUNITY ECOLOGY OF SMALL MAMMALS AND COTTONTAIL RABBITS OF OKLAHOMA

by

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DEDICATION

This work is dedicated to the memory of my grandfather

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## PREFACE

The cross timbers region of Oklahoma covers an expansive area of central and eastern Oklahoma and supports a large part of the state's livestock production. Rugged topography and thick, woody brush hinder optimum forage quality and necessitate brush control withn which to maximize economic potential. Much research has been done to improve the effectiveness, effeciency and economic feasibilty of brush control practices such as prescribed burning and herbicide application. The feasibility of using combined applications of herbicide and prescribed burning to control brush and improve livestock grazing potential on cross timbers rangeland in Oklahoma is currently being explored at the Cross Timbers Experimantal Range in Payne County, Oklahoma. This 648 ha area of north-central Oklahoma is a mosaic of oak (Quercus sp.) woodlands; mixed grass prairies dominated by big bluestem (Andropogon gerardii), little bluestem (Schizachrium scoparium), and indian grass (Sorghastrum nutans); and shallow, sandy savannas invaded by eastern red cedar (Juniperus virginianus).

These woodlands, prairies and savannas provide suitable habitat for a community of small mammals (8

species) and cottontail rabbits (Sylvilagus floridanus) which coexist in this area with cattle. This community of vertebrates, as with any wildlife community, interacts with its parasitic component. This symbiotic interaction or relationship is termed host-parasite community ecology and is a poorly understood subject. This is especially true for those communities inhabiting the cross timbers region of Oklahoma.

Vegetative density, composition, height, canopy cover, and availability of forage to wildlife can be affected by burning and herbicide application, therefore influencing host-parasite relationships. The purpose of this study was to determine how applications of the herbicides triclopyr (3,5,6-trichloro-2-pyridinyloxyacetic acid) butoxyethyl ester and tebuthiuron (N-[5-(1,1 dimethyl ethyl)-1,3,4 thiadiazol-2-yl]-N,N' dimethylurea) with prescribed burning can influence host-parasite community ecology of small mammals and cottontail rabbits inhabiting the Cross Timbers Experimental Range.

This thesis is comprised of five manuscripts formatted for submission to the Journal of Wildlife Diseases. The manuscripts (chapters I, II, III, IV, and V) are complete as written and do not need supporting material.

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# CHAPTER I

# *OBELISCOIDES CUNICULI* PARASITISM IN COTTONTAIL RABBITS (*SYLVILAGUS FLORIDANUS*) IN RESPONSE TO HABITAT MODIFICATION IN CROSS TIMBERS OF OKLAHOMA

**ABSTRACT:** The influence of habitat modification on Obeliscoides cuniculi populations in cottontail rabbits (Sylvilagus floridanus) was examined from 1987 to 1988 in the cross timbers ecosystem of Oklahoma. Five experimental brush control treatments, using combinations of the herbicides tebuthiuron and triclopyr with or without prescribed burning, were replicated 4 times on 20 32.4 ha pastures. A total of 205 rabbits (25 juvenile and 180 adult) was collected with an overall prevalence of infection of 97%. Prevalence was not influenced by brush treatment, season, or year. Distribution of O. cuniculi populations within cottontail rabbits was significantly influenced by season, with a higher degree of overdispersion in winter. The influence of brush treatment on the degree of overdispersion was not clear, but seasonal variation was low on untreated control pastures. Abundance of O. cuniculi infections was significantly affected by brush treatment, season, and year of collection. Mean abundances were lower on annually burned triclopyr treatments than all other experimental pastures. Abundance of O. cuniculi in cottontail rabbits was higher in summer (58.8 $\pm$ 7.0) than winter (23.0 $\pm$ 4.4). Variations in the intensity of the prescribed burns and season were probably important factors that influenced O. cuniculi parasitism in cottontail rabbit populations.

Key words: Cottontail rabbit, Sylvilagus floridanus, brush management, Obeliscoides cuniculi, trichostrongylidae,

herbicides, prescribed burning, Tebuthiuron, Triclopyr.

## INTRODUCTION

Parasitism in wildlife populations is strongly influenced by the type of habitat in which the host resides (Custer and Pence, 1981; Pence et al., 1983; Corn et al., 1985). Geographical variation in wildlife helminth communities appears to be associated in part with changes in selected habitat attributes. For example, Mollhagen (1978) suggested that helminth community composition in cotton rat (Sigmodon hispidus) populations in Texas was influenced by moisture characteristics of the habitat. Similarly, Kinsella (1974) reported significant differences in prevalence and abundance of nematode and cestode parasites among cotton rat populations in freshwater marshes, saltwater marshes, and relatively xeric upland habitats from north-central to south-central Florida. Jacobson et al. (1978) noted significant differences in abundances of nematode and cestode parasites of eastern cottontail rabbit (Sylvilagus floridanus) populations between southeast and southwest Virginia; however, these two areas differed markedly in altitude, topography, growing season duration, soil pH, and land management practices which made interpretation difficult.

Although previous studies demonstrate a strong relationship between parasite communities of a host and habitat attributes when compared across geographic regions,

they provide little insight into host-parasite relationships following habitat alterations in a local area. Natural and man-induced successional changes are a common component of wildlife habitats. Intensive land-use and range/wildlife improvement practices are capable of drastic alterations of both the structure and composition of wildlife habitat, especially in the vegetative component. Management techniques such as prescribed burning and herbicide applications are routinely used to reverse succession across large areas of habitat with lasting effects. Changes in physical and biological attributes of habitat undoubtedly occur following intensive treatments such as these, and potentially can alter host-parasite community ecology.

Our understanding of effects of local habitat modification on host-parasite relationships is limited. Issac (1963) discovered that black-tailed deer (Odocoileus hemonius columbianus) diseases caused by liver flukes and lung worms were curtailed by the Tillamook burn of Oregon in 1933. Bendell (1974) found that although internal and external parasitism of blue grouse (Dendragapus obscurus) initially decreased following an intense wildfire, parasite species richness and frequency of infection increased 12 years later.

Obeliscoides cuniculi (Graybill, 1923) is a common trichostrongylid stomach worm of cottontail rabbits that is widely distributed in North America (Ward,1934; Morgan and

Waller, 1940; Moore and Moore, 1947; Franklin et al., 1966; Stringer et al., 1969; Andrews et al., 1980; Strohlein and Christensen, 1983). Several studies on O. cuniculi have examined their life history (Alicata, 1932), effects on rabbit nutritional physiology (Pace and Fransden, 1982), seasonal variation (Gibbs et al., 1977), and arrested development (Michel et al., 1975). However, only one study has investigated the distribution, abundance, and ecology of this trichostrongyle nematode within the Cross Timbers ecosystem of central Oklahoma (Ward,1934) where range improvement practices are commonly used. My objective was to determine if brush management strategies using combinations of fire and herbicides influence the distribution, abundance, or prevalence of O. cuniculi infections of cottontail rabbit populations in the Cross Timbers ecosystem of Oklahoma.

## MATERIALS AND METHODS

### Study area

This study was conducted on the Cross Timbers Experimental Range (CTER), which is located approximately 11 km west of Stillwater, Oklahoma. The CTER is a 648-ha research area originally composed of blackjack oak (Quercus marilandica)-post oak (Q. stellata), and eastern redcedar (Juniperus virginiana) upland forest intermixed with tall grass prairie (Ewing et al., 1984). The CTER includes 20 32.4-ha (0.42 x 0.83 km) fenced experimental pastures,

representing 4 replications of 4 brush management treatments, using combinations of herbicide and annual prescribed burning, and an untreated control. This provides a 2 x 2 factorial design consisting of 4 replications of 5 treatments (Appendix D). The experimental treatments included: (1) tebuthiuron (N-[1,1-dimethyl-ethyl)-1,3,4-thiadiazol-2 yl]-N,N'-dimethylurea), a soil-applied herbicide (Elanco Products Co., Division of Eli Lilly and Co., Indianapolis, Indiana 46285), applied aerially at 2.2 kg per ha in March 1983; (2) tebuthiuron applied (as with treatment #1) with annual prescribed burning in April beginning in 1985; (3) triclopyr ([(3,5,6-trichloro-2-pyridinyl)oxy] acetic acid), a foliage-applied herbicide (Dow Chemical Co., Midland, Michigan 48674), applied aerially at 2.2 kg per ha in June 1983; (4) Triclopyr applied (as with treatment #3) with annual prescribed burning in beginning in April 1985; and (5) untreated control. No treatments were burned in 1988. All experimental pastures were moderately grazed by cattle during the spring and summer.

Herbicide-treated pastures produced more grasses and forbs compared to untreated control pastures (Engle et al., 1987). Both herbicides killed a high proportion of the dominant overstory oak species, but woody understory species such as buckbrush (Symphoricarpos orbiculatus), elm (Ulmus americana), and chittamwood (Bumelia lanuginosa) were not reduced as much by triclopyr as by tebuthiuron (Stritzke et

al., 1987). Competition by understory woody species reduced the production of herbaceous plants after the triclopyr treatment.

Data collection

A total of 205 cottontail rabbits was collected during winter (January) and summer (July) of 1987 and 1988. An attempt was made to collect 5 specimens from each of 2 replications for each treatment. Carcasses were necropsied within 24 hours of collection or frozen until necropsy could be performed. Stomach worms that were recovered from the gastric mucosa and food contents were counted and stored in 70% ethanol. O. cuniculi specimens were cleared with lactophenol and identified by microscopic examination. Representative specimens of O. cuniculi recovered from this study were deposited in the U. S. National Parasite Collection, Beltsville, Maryland 20705, U. S. A. (Accession No. 80494).

Data analysis

Abundance and prevalence were defined by Margolis et al. (1982). Host age was determined using a combination of reproductive status and body weight. Cottontail rabbits $\geq$ 800 g body weight and reproductively active individuals between 650 and 799 g were considered adults. Only abundance data for adult cottontail rabbits ($n$ = 180) were used in data analyses for the main effects of treatment, season, year, and sex.

Overdispersion as defined by Bliss and Fisher (1953), has been used to describe frequency distributions of helminths in which a small number of host individuals harbor many helminth individuals and many hosts harbor little to no individuals of a particular helminth species (Waid et al., 1985; Corn et al., 1985). Overdispersion was indicated when helminth frequency distributions revealed a variance significantly larger ($P \leq 0.05$) than the mean abundance using a chi-square distribution. The degree of overdispersion was measured by the negative binomial parameter k (Bliss and Fisher, 1953) which is an inverse measure of the degree of overdispersion. Differences in overdispersion (k) among rush treatments and seasons were then evaluated by analysis of variance using Anscombe's transform, $Log_{10}(x + 1/2k)$, of abundance data (Bliss and Owen, 1958). Overdispersed O. cuniculi abundances for the adult cottontail rabbits were independently rank transformed prior to data analysis as a method to analyze non-normally distributed data (Conover and Iman, 1981; Waid et al., 1985).

Main and interactive effects of treatment, season, and year on rank transformed abundances were examined with a factorial analysis of variance. Biological significance was set at $P \leq 0.100$. Specific contrasts (1 df) were utilized to compare variation among treatment components (burned vs. unburned, untreated control vs. brush treatments, tebuthiuron vs. triclopyr). Protected multiple comparisons

(LSD) were used when significant ($P \leq 0.05$) differences were detected by analysis of variance. The Statistical Analysis System (SAS) was used for all data analyses (SAS, 1985; SAS Institute, Raleigh, North Carolina). Copies of the raw and rank transformed data are available upon request from Robert L. Lochmiller.

## RESULTS AND DISCUSSION

### Prevalence

A total of 95 male (86 adult) and 110 female (94 adult) cottontail rabbits was collected from the CTER with an overall prevalence of 97% for O. cuniculi. Juvenile cottontail rabbits ($n = 25$) were not included in data analyses due to significant differences in O. cuniculi mean abundances ($P \leq 0.001$) when compared to adults. Infection intensities ranged from 1 - 435 worms/host; only 5 uninfected rabbits were observed in winters of 1987 and 1988 (Table 1). Prevalence of O. cuniculi infections in my study was higher than other studies in Oklahoma and surrounding states. Ward (1934) and Smith (1940) reported prevalences of 47% and 0% in samples of 52 and 31 cottontail rabbits in Oklahoma, respectively. Franklin et al. (1966) had a prevalence of 16% in a sample of 138 cottontail rabbits from Kansas. O. cuniculi infections in our study were similar to surveys in the southeastern United States where prevalence approached 100% (Andrews et al., 1980; Jacobson et al., 1978; Moore and Moore, 1947). No

differences in prevalence were found among cottontail rabbits from the brush treatments or controls.

Distribution and overdispersion

Variances were significantly larger than the mean number of O. cuniculi individuals/adult cottontail rabbit for all treatments in each season (Table 2), which was indicative of an overdispersed parasite distribution (Bliss and Fisher, 1953). Low k values ($\leq$1.0) indicated a high degree of parasitic aggregation (Bliss and Fisher, 1953; Corn et al., 1985) within our host population, but there was no significant difference ($P \geq 0.100$) in k values due to brush treatment. Cottontail rabbit populations from herbicide-treated pastures showed a greater amount of variation in k values between seasons than those from untreated controls. Common k statistics from 1988 indicated differences ($P < 0.055$) between O. cuniculi overdispersion in control and brush-treated pastures. Degree of overdispersion was significantly greater ($P < 0.001$) in winter than summer for both years. The k value of 25 juvenile cottontail rabbits that were collected primarily in summer was 2.90.

Distribution of O. cuniculi infections in cottontail rabbit populations in the cross timbers supports previous studies that indicate seasonal changes foster overdispersion (Corn et al., 1985; Pence and Windberg, 1984). However, other factors such as habitat heterogeneity (Anderson, 1982)

also could be important in overdispersion in O. cuniculi as indicated by differences in the seasonal variation of k values between treated and untreated pastures. Natural successional changes, vegetative composition, patchiness of treatments, and microclimates occurring on herbicide treated pastures could have contributed to these observed differences with untreated controls. Intrinsic host-related variables such as cottontail rabbit habitat use patterns also may be factors that contribute to overdispersion on my study area.

Abundance

Mean O. cuniculi abundances (Table 3) were significantly different between seasons ($P < 0.001$), treatments ($P < 0.057$), years ($P < 0.053$), and a significant ($P < 0.013$) brush treatment by year interaction occurred. Mean rank abundances were considerably higher in summer than winter for both years sampled. Mean abundance for O. cuniculi across all treatments was 58.8 $\pm$ 7.0 and 23.0 $\pm$ 4.4 worms/host (wph) for summer and winter, respectively. Mean abundance was higher in 1987 (42.8 $\pm$ 5.8 wph) than 1988 (34.0 $\pm$ 5.8 wph).

Mean rank abundances of O. cuniculi in cottontail rabbits collected in 1988 from annually burned treatments (41.1 $\pm$ 4.2 wph) were lower ($P < 0.040$) than those from unburned (48.0 $\pm$ 3.7 wph experimental treatments. Multiple comparisons among treatments showed triclopyr treatments

subjected to annual prescribed burning had a mean rank abundance for O. cuniculi that was lower ($P < 0.050$) than the other four treatments. Abundances of O. cuniculi were not different ($P > 0.230$) between triclopyr and tebuthiuron-treated pastures in 1987 or 1988. There was no significant ($P > 0.150$) differences in abundances between control and treated pastures for 1987.

Seasonal differences between winter and summer O. cuniculi abundances in cottontail rabbits are well documented across the United States. Andrews et al. (1980) found that O. cuniculi abundances in cottontail rabbits collected in spring were 2 to 4 times greater than those in winter. Jacobson et al. (1978) reported similar results for cottontail rabbits from Virginia, and speculated that variable climate and host hormonal changes influenced O. cuniculi abundance. In our study, seasonal variation was more profound during 1988 than 1987 as demonstrated by a larger summer to winter ratio of mean rank abundance. This was probably due to a harsh winter in 1988, during which record snowfalls and ice storms were recorded. Winter of 1987 was mild and wet and likely provided optimal conditions for parasite transmission (Alicata, 1932) resulting in less variation in worm burdens between seasons.

Management Implications

Effects of wildfire and prescribed burning on helminth parasitism have not been well documented. Habitat modifications induced by wildfire can produce optimal

conditions for establishment of arthropod intermediate hosts of pathogenic intestinal worms of blue grouse (Bendell, 1974). Prescribed fire for habitat management of Stone's sheep (Ovis dalli stonei) decreased Protostrongylus sp. larval counts in feces of sheep that utilized burned ranges during winter (Seip and Bunnell, 1985). Cottontail rabbits in our study area experienced similar host-parasite influences from 1987 to 1988. Prescribed burning at CTER occurred in April when infective larvae and eggs should have been abundant in the environment and conditions for transmission were ideal. Burning may have decreased the number of these infective stages available to foraging cottontail rabbits which resulted in lower mean abundances among animals collected from burned sites. This was found to be true of rabbits collected from triclopyr-treated pastures that were burned annually. Spotty, nonuniform burns resulting from a lack of adequate fuel, were probably responsible for higher survival of infective O. cuniculi larvae on annually burned tebuthiuron-treated pastures.

This study provided additional evidence that habitat alterations, whether natural or man-induced, can influence host-parasite population relationships in a local area. Host-parasite responses to a given habitat alteration are not always consistent, however my study demonstrates they differ from those responses in untreated habitats. Because habitat modification practices, such as those using

herbicides and fire, vary greatly in their effects on vegetation structure and how they are applied, general statements about host-parasite responses may be difficult to make. Longer term research is needed on entire helminth communities to better understand and predict these responses.

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Table 1. Prevalence (number infected/number examined) of Obeliscoides cuniculi in cottontail rabbits collected from 5 experimental brush control treatments on the Cross Timbers Experimental Range, Payne County, Oklahoma.

| | 1987 | | 1988 | |
|---|---|---|---|---|
| Brush treatment | Winter | Summer | Winter | Summer |
| Tebuthiuron | 10/10 | 10/10 | 13/13 | 10/10 |
| Tebuthiuron with annual burning | 10/11 | 10/10 | 9/10 | 10/10 |
| Triclopyr | 10/10 | 10/10 | 10/10 | 10/10 |
| Triclopyr with annual burning | 9/10 | 10/10 | 10/10 | 10/10 |
| Control | 9/10 | 11/11 | 9/10 | 10/10 |
| Total | 48/51 | 51/51 | 51/53 | 50/50 |

Table 2. Determination of overdispersion ($\bar{X}/S^2$)[a] and degree of aggregation (K) of Obeliscoides cuniculi individuals in adult cottontail rabbits collected from 5 experimental brush control treatments on the Cross Timbers Experimental Range, Payne County, Oklahoma (n = 180).

| | 1987[b] | | | | 1988[b] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Winter | | Summer | | Winter | | Summer | | Total |
| Brush treatment | $\bar{X}/S^2$ | K | $\bar{X}/S^2$ | K | $\bar{X}/S^2$ | K | $\bar{X}/S^2$ | K | K |
| Tebuthiuron | 0.091 | 0.03 | 0.023 | 1.30 | 0.027 | 0.93 | 0.044 | 2.37 | 0.95 |
| Tebuthiuron with annual burning | 0.011 | 0.54 | 0.047 | 2.74 | 0.153 | 1.34 | 0.055 | 0.45 | 0.40 |
| Triclopyr | 0.005 | 0.30 | 0.024 | 1.25 | 0.100 | 1.16 | 0.030 | 1.84 | 0.49 |
| Triclopyr with annual burning | 0.146 | 1.51 | 0.017 | 0.74 | 0.045 | 0.52 | 0.061 | 2.13 | 0.58 |
| Control | 0.027 | 1.00 | 0.018 | 1.12 | 0.205 | 1.03 | 0.019 | 1.17 | 0.67 |

[a] (mean abundance/variance) Where a small number of host individuals harbor many parasite individuals and many of the hosts harbor little to no individuals of a particular parasitic species (based on the frequency distribution of individual parasites).

[b] All variances were significantly larger than respective mean abundances ($P \leq 0.05$)

Table 3. Mean seasonal abundance ($\bar{X} \pm SE$) of *Obeliscoides cuniculi* in cottontail rabbits collected from 5 experimental brush control treatments on the Cross Timbers Experimental Range, Payne County, Oklahoma. Sample size is in parentheses.

| | 1987 | | | | 1988 | | | |
|---|---|---|---|---|---|---|---|---|
| | Winter | | Summer | | Winter | | Summer | |
| Brush treatment | Adult | Juvenile | Adult | Juvenile | Adult | Juvenile | Adult | Juvenile |
| Tebuthiuron | 10.3 ±3.4 (10) | NC[a] | 54.4 ±16.1 (10) | 3.0 (1) | 33.5 ±9.7 (13) | NC | 51.9 ±12.2 (10) | 32.0 ±31.0 (2) |
| Tebuthiuron with burn | 49.2 ±20.3 (11) | NC | 55.4 ±11.4 (10) | 101.0 (1) | 7.4 ±2.2 (10) | NC | 90.6 ±45.2 (10) | 67.0 (1) |
| Triclopyr | 56.9 ±34.9 (10) | 36.0 (1) | 65.4 ±18.3 (10) | 54.4 ±49.5 (2) | 10.4 ±3.2 (10) | NC | 59.3 ±18.1 (10) | 75.5 ±23.0 (4) |
| Triclopyr with burn | 8.8 ±2.5 (10) | NC | 43.8 ±23.0 (10) | 73.0 ±10.0 (5) | 11.0 ±4.9 (10) | NC | 33.0 ±8.8 (10) | 82.3 ±7.4 (3) |
| Control | 36.3 ±11.6 (10) | NC | 61.6 ±22.1 (11) | 28.5 ±6.1 (4) | 4.0 ±1.4 (10) | NC | 60.7 ±18.8 (10) | 78.0 (1) |

[a] NC = no rabbits collected

# CHAPTER II

# INFLUENCE OF HABITAT MODIFICATION ON INTESTINAL HELMINTH COMMUNITY ECOLOGY OF COTTONTAIL RABBITS (*SYLVILAGUS FLORIDANUS*) IN THE CROSS TIMBERS OF OKLAHOMA

**ABSTRACT:** The influence of 5 brush management treatments using the herbicides tebuthiuron and triclopyr, with or without prescribed burning, on the intestinal helminth community of cottontail rabbits (Sylvilagus floridanus) was studied in 1987 on the Cross Timbers Experimental Range in Payne County, Oklahoma. Six helminth species were recovered (Dermatoxys veligera, Trichostrongylus calcaratus, Passalurus nonanulatus, Wellcomia longejector, Taenia pisiformis [cystercercus], and Mosgovoyia pectinata americana) from a total of 102 rabbits (88 adult and 14 juveniles) collected over two seasons (winter and summer). Prevalence of M. pectinata americana in cottontail rabbits was significantly greater in untreated control pastures than herbicide treated pastures in winter, while prevalence of T. pisiformis was significantly greater in burned than unburned pastures. Abundances of helminth species harbored in the intestinal tract of cottontail rabbits were unaffected by brush treatments. M. pectinata americana abundance demonstrated a highly significant increase from winter to summer, conversely, abundance of oxyurid pinworms combined was significantly higher in winter than summer. Helminth community dynamics were significantly influenced by season, but were unaffected by brush treatments. Habitat modification could have influenced cestode transmission by altering the ecology of invertebrate and vertebrate hosts.

Key words: Cottontail rabbit, Sylvilagus floridanus,

helminth community, herbicides, triclopyr, tebuthiuron, prescribed burning, brush management, Mosgovoyia pectinata americana, Taenia pisiformis, oxyuridae, trichostrongylidae.

## INTRODUCTION

Parasite communities harbored by the eastern cottontail rabbit (Sylvilagus floridanus) show a considerable amount of geographical variation in species richness and abundance (Ward, 1934; Morgan and Waller, 1940; Smith, 1940; Moore and Moore, 1947; Franklin et al., 1966; Stringer et al., 1969; Novelsky and Dyer, 1970; Andrews et al., 1980; Strohlein and Christensen, 1983). Previous studies indicate that geographical variation in helminth community dynamics is associated with extrinsic habitat factors which change across geographic regions (Custer and Pence, 1981; Pence et al., 1983; Corn et al., 1985). For example, parasite populations in the cotton rat (Sigmodon hispidus) have been shown to differ between mesic and xeric habitats (Mollhagen, 1978; Kinsella, 1974). Jacobson et al. (1978) reported differences in abundances of helminths in cottontail rabbit populations from southeast and southwest Virginia associated with a variety of habitat factors.

Habitat factors vary not only across the geographic range of a host species but also across time within the habitat of a resident population. Natural, progressive, successional changes as well as man-induced habitat

alterations can change a variety of habitat factors in a local area. Induced changes of extrinsic habitat factors such as these could easily alter host, parasite community, and habitat interrelationships. However, only a few studies have actually examined the effects of habitat alterations on host-parasite community relationships. Issac (1963) reported that liver fluke and lungworm infections of blacktailed deer (Odocoileus hemionus) were curtailed by wildfires in Oregon. Similarly, Bendell (1974) found a strong relationship between elapsed time after wildfires and internal and external parasitism of blue grouse (Dendragapus obscurus).

Cottontail rabbits are ubiquitous herbivore components of the cross timbers ecosystem in central Oklahoma. To reduce woody plant cover and increase herbaceous understory production herbicides and prescribed burning are recommended techniques for improving grazing potential in the cross timbers. These brush management strategies usually result in dramatic alterations in both habitat structure and composition (Scifres, 1980). My objective was to examine the impact of these brush management strategies in the cross timbers on parasite communities of the cottontail rabbit by analyzing distribution, abundance, intensity, prevalence, and species richness of intestinal helminths.

## MATERIALS AND METHODS

### Study area

This study was conducted on the Cross Timbers Experimental Range (CTER), which is located approximately 11 km west of Stillwater, Oklahoma. The CTER is a 648-ha research area originally composed of blackjack oak (*Quercus marilandica*)-post oak (*Q. stellata*) and eastern redcedar (*Juniperus virginiana*) upland forest intermixed with tallgrass prairie (Ewing et al., 1984). The CTER includes 20 32.4-ha (0.42 x 0.83 km) fenced experimental pastures, representing 4 replications of 4 brush management treatments, using combinations of herbicide and annual prescribed burning applications and an untreated-control. This provides a 2 x 2 factorial design of 4 replications of 5 treatments (Appendix D). The experimental treatments include: (1) tebuthiuron (N-[5-(1,1-dimethyl-ethyl)-1,3,4-thiadiazol-2 yl]-N,N'-dimethylurea), a soil applied herbicide (Elanco Products Co., Division of Eli Lilly and Co., Indianapolis, Indiana 46285), applied aerially at 2.2 kg per ha in March 1983; (2) tebuthiuron applied (as with treatment #1) with annual prescribed burning beginning April, 1985; (3) triclopyr ([(3,5,6-trichloro-2-pyridinyl) oxy] acetic acid), a foliage applied herbicide (Dow Chemical Co., Midland, Michigan 48674), applied aerially at 2.2 kg per ha in June 1983; (4) triclopyr applied (as with treatment #3) with annual prescribed burning begining in April, 1985; and (5) untreated control. All experimental

pastures were moderately grazed by cattle during the spring and summer.

Herbicide-treated pastures produced more grasses and forbs compared to the untreated control pastures (Engle et al., 1987). Both herbicides killed a high proportion of the dominant overstory oak species, but woody understory species such as buckbrush, (Symphoricarpos orbiculatus), elm (Ulmus americana) and chittamwood (Bumelia lanuginosa) were not reduced as much by triclopyr as by tebuthiuron (Stritzke et al., 1987). Competition by understory woody species reduced the production of herbaceous plants after the triclopyr treatment.

Data collection

Forest floor material (litter and mulch <1.5 meters above the soil surface) was collected from each pasture within seven caged quadrats (50 x 50 cm) placed inside grazing exclosure cages randomly located within a permanent sampling location in each pasture. Samples, collected from mid-July through mid-August, were dried in a forced air oven at 70$^{o}$C then weighed. Differences between treatments were determined by 2-way analysis of variance.

An attempt was made to collect 5 cottontail rabbits from each of 2 replications for each treatment in winter (January) and summer (July) of 1987. Carcasses were necropsied within 24 hours of collection or frozen until necropsy could be performed. Intestinal tracts were removed

from the carcasses at necropsy and the entire tract was dissected laterally and examined grossly for tapeworms. Contents were then collected and stored in 70% ethanol for subsequent microscopic examination. Small intestinal contents were filtered through a 150 micron sieve and a 25% aliquot was examined. The combined cecal and large intestinal contents were sieved as above and a 10% aliquot was examined. Recovered parasites were counted and stored in 70% ethanol. Nematodes were cleared with lactophenol and identified by microscopic examination. Tapeworms were fixed in alcohol-formalin-acetic acid (AFA) then stained with Delafields iron hematoxylin differential stain. Representative specimens of helminth species recovered from our study were deposited in the U. S. National Parasite Collection, Beltsville, Maryland 20705, U. S. A. (Accession Nos. 80495 - 80500).

Data analysis

Abundance, intensity, and prevalence are defined by Margolis et al. (1982). Host age was determined using a combination of reproductive status and body weight. Cottontail rabbits $\geq$800 g body weight and reproductively active individuals between 650 and 799 g were considered adults. The parasite community of a small sample of juveniles ($n$ = 13) collected in the summer differed from adults; hence, only adult cottontail rabbit ($n$ = 88) abundance data were analyzed for main effects of treatment, season and sex. Overdispersion (Bliss and Fisher 1953) has

been used to describe the frequency distributions of common (≥25% prevalence) species of intestinal helminths where a small number of host individuals harbor many helminth individuals and many of the hosts harbor little to no individuals of a particular helminth species (Waid et al., 1985; Corn et al., 1985). Overdispersion was indicated when the variance for a particular species was significantly ($\underline{P} \leq 0.050$) larger than the mean abundance using a chi-square distribution ($\underline{X}^2$, $[S^2/X] \times df$). The degree of overdispersion was measured by the negative binomial parameter k (Bliss and Fisher, 1953) which is an inverse measure of the degree of overdispersion. Differences in overdispersion (k) among brush treatments and seasons were evaluated by factorial analysis of variance using Anscombe's transform (common k estimate), $\log_{10}(x + 1/2k)$, of abundance observations (Bliss and Owen, 1958). Overdispersed helminth abundances for the 88 sample data set were independently rank transformed (Conover and Iman, 1981; PROC RANK, Statistical Analysis Systems, 1985, SAS Institute, Raleigh, North Carolina) for each common parasite species prior to data analysis as a method to analyze non-normally distributed data (Conover and Iman, 1981; Waid et al., 1985).

The main and interactive effects of treatment, season and sex were examined with a factorial analysis of variance and multivariate analysis of variance (MANOVA) for the

ranked abundances of recovered helminth species (PROC GLM, SAS). Oxyurid pinworm (Dermatoxys veligera, Wellcomia longejector, Passalurus nonanulatus) abundances were combined and analyzed as one dependent variable. Specific contrasts were utilized to compare variation in abundance data within brush treatment categories (burned vs. unburned, tebuthiuron vs. triclopyr, control vs. brush treated). Protected multiple comparisons (LSD) were used when analysis of variance rejected the null hypothesis that brush treatment categories were similar. Prevalence data was subjected to chi-square analysis to determine homogeneity between seasons and brush treatment. Biological significance was set at $P \leq 0.100$ for data analyses. Copies of the raw and rank transformed data are available upon request from Robert L. Lochmiller.

## RESULTS

### Forest floor material

Forest floor material (Fig. 2) represented accumulations of dead vegetation at ground level. Leaf litter was the primary component of forest floor material in untreated pastures. Forest floor material differed ($P < 0.001$) among the control and brush treatments. Untreated control pastures had about 60% more material accumulated on the forest floor than the brush treatments.

### Helminth fauna

Four species of intestinal nematodes (D. veligera;

Rudolphi, 1819; P. nonanulatus; Skinker, 1931; T. calaratus; Ransom, 1911; and W. longejector; Hannum, 1943) and two species of cestodes (T. pisiformis; Bloch, 1780 and M. pectinata americana; Douthitt, 1915) were recovered from 102 cottontail rabbits (88 adults, including 44 male and 44 female; 14 juveniles). Most helminth species were common, occurring in all experimental treatments in both winter and summer. W. longejector occurred in only 2 animals, both collected from the same pasture; a tebuthiuron treatment subjected to annual burning. Species richness showed no relationship with experimental treatment.

Mean abundances of T. pisiformis and D. veligera were significantly ($P < 0.050$) higher in adults than juveniles. There were no age-related differences in mean abundances for M. pectinata americana, T. calcaratus, and P. nonanulatus.

Helminth prevalence

Prevalence (Table 1) of D. veligera infection in cottontail rabbits differed significantly ($P < 0.005$) between seasons, with lower prevalences in winter (6%) than summer (58%). There were no seasonal differences ($P > 0.100$) in prevalence of T. calcaratus, P. nonanulatus, T. pisiformis, M. pectinata, and W. longejector. There was also no difference ($P > 0.100$) in prevalence between seasons for oxyurid pinworms combined. Prevalence of M. pectinata americana and T. pisiformis infections were significantly affected by experimental brush treatments. Prevalence of M. pectinata americana was higher ($P < 0.010$) on untreated

controls (100%) than herbicide- treated pastures (53%). There were no differences ($P > 0.100$) in prevalence of M. pectinata americana infections between burned and unburned treatments or tebuthiuron and triclopyr treatments. Prevalence of T. pisiformis infection was higher ($P < 0.050$) on burned (93%) than on unburned (65%) treatments. No differences ($P > 0.100$) existed in prevalence of T. pisiformis between untreated controls and herbicide treatments or tebuthiuron and triclopyr treatments. Overall prevalences of D. veligera (19%), W. longejector (2%) , P. nonanulatus (32%), and T. calcaratus (97%) were not affected by brush treatment. Prevalence of oxyurid pinworm infections combined was 47%.

Helminth abundance and intensity

Mean rank abundance and intensity data for helminths recovered from our study showed no significant difference ($P > 0.100$) between male and female cottontail rabbits (Table 2). However, mean rank abundances of T. calcaratus, M. pectinata americana, and oxyurid pinworms combined showed significant season by sex interactions. T. calcaratus ($P < 0.060$) and M. pectinata ($P < 0.100$) infections during summer were higher among females than males, while the reverse was true in winter. Conversely, oxyurid pinworms combined were higher ($P < 0.097$) among females in winter and higher among males in summer.

Except for T. pisiformis, abundances for all helminths

recovered from our study differed significantly between seasons (Table 3). Mean rank abundances were lower for T. calcaratus ($P < 0.001$), and higher for M. pectinata americana ($P < 0.001$) and oxyurid pinworms combined ($P < 0.041$) in summer than winter. Mean intensities were also higher for M. pectinata americana ($P < 0.001$) and T. pisiformis ($P < 0.048$) in summer than winter. Mean intensities for all other helminths did not differ ($P > 0.100$) between seasons. Mean rank abundances and intensities for all helminths recovered showed no significant relationship ($P > 0.100$) to brush treatment.

Multivariate analysis of variance indicated that mean rank abundances of species within helminth communities were significantly ($P < 0.001$) influenced by season, with a significant ($P < 0.064$) season by sex interaction. However, no significant differences ($P > 0.100$) were appparent between host sexes or among brush treatments

Helminth distribution

All helminth species recovered with the exception of M. pectinata, had variances significantly ($P < 0.050$) larger than respective mean abundances across all treatments and seasons (Table 4), indicating an overdispersed distribution (Bliss and Fisher, 1953). However, variances of M. pectinata americana were not significantly ($P > 0.050$) larger than respective mean abundances in winter, but showed significant ($P < 0.050$) overdispersion in summer. A low range of M. pectinata infection (0 - 4), with only 1 rabbit

harboring a burden of 4 worms, was responsible for low variances within winter samples. Analysis of variance for common k estimates revealed significant seasonal effects for the distribution of T. calcaratus ($P < 0.001$), M. pectinata americana ($P < 0.004$), and all oxyurid pinworms combined ($P < 0.017$); however, no significant differences in helminth distribution (k values) were detected among brush treatments. T. pisiformis distribution was not affected ($P > 0.100$) by season or brush treatment.

## DISCUSSION

### Effects of habitat modification

Spring burning is a common practice in the tallgrass prairie and cross timbers because it removes dead herbage and litter, which often improves the diet quality of herbivores (Allen et al., 1976; Grelen and Epps, 1967; McGinty et al., 1983) and induces succession of plant communities to dominance by tallgrasses (Engle, 1987). Prescribed burning on the CTER occurred in late March and early April, when helminth infective stages and invertebrate intermediate hosts should have been abundant and conditions for transmission were ideal. However, herbicides affected the greater change in vegetation by reducing oak (Quercus sp.) and other hardwoods in the overstory and increasing herbaceous understory production. Plant communities of both burned and unburned herbicide-treated pastures has undergone retrogression since 1984 when herbicides were first applied

(Stritzke et al., 1987).

Helminth fauna new to Oklahoma

M. pectinata americana, W. longejector, and D. veligera are reported for the first time in eastern cottontail rabbits from Oklahoma. M. pectinata americana (formerly Cittotaenia pectinata; Arnold, 1938) has been recovered from the small intestine of cottontail rabbits from a variety of locations (Erickson, 1947; Novelsky and Dyer, 1970). W. longejector was first described by Hannum (1943) from lagomorphs and rodents in Arizona. D. veligera, a common oxyurid pinworm of cottontail rabbits, has been found in Kansas (Franklin et al., 1966) and other locations in the U. S. (Cheatum, 1943; LeDune, 1933; Llewellyn and Handley, 1945; Jacobson et al., 1978; Moore and Moore, 1947; Novelsky and Dyer, 1970; Stringer et al., 1969; Rozycki, 1941; Strohlein and Christensen, 1983). With the exception of W. longejector, these helminth species are probably common components of the helminth community of cottontail rabbits in Oklahoma, and their delayed documentation is due to limited helminth research on wildlife species in Oklahoma (Ward, 1934; Smith, 1940).

Cestode parastism

Cottontail rabbits serve as definitive hosts for M. pectinata americana and intermediate hosts for T. pisiformis. Orbatid mites are common intermediate hosts for anoplocephaline cestodes such as M. pectinata americana

(Stunkard, 1941). T. pisiformis exists as a larval cystercercus in the intermediate host, developing into an adult tapeworm in canines. Overall prevalence of M. pectinata americana was considerably higher than the 4.5% reported in cottontail rabbits from Minnesota (Erickson, 1947) and 6.5% from North Dakota (Novelsky and Dyer, 1970). Unlike Cittotaenia sp. infections in cottontail rabbits from Virginia (Jacobson et al., 1978) and Kentucky (Strohlein and Christensen, 1983), no seasonal differences in prevalence of M. pectinata were evident in our study.

Observed differences in the prevalence of M. pectinata infections among experimental brush treatments could have been a reflection of intermediate host availability. Prevalence of M. pectinata americana in cottontail rabbits has been shown to be related to the availability of soil dwelling orbatid mites. Mitchell (1979) reported that orbatid mite survival is highly temperature dependent and species diversity is limited by specific microhabitat factors such as soil depth, moisture, preferred food resources, and degree of microbial decomposition. Seastedt (1984) reported a linear correlation between microarthropod population numbers, to include orbatid mites, and the amount of leaf litter on the forest floor. Defoliation by herbicides has been shown to increase midday soil temperatures (Santillo et al., 1989). Burning (Heyward and Tissot, 1936; Pearse, 1943) as well as herbicide applications (Guerra et al., 1982) can reduce acarine soil

mite abundance. Greater accumulations of organic matter on the forest floor and an overstory conopy providing more optimal abiotic conditions (temperature, humidity) could have contributed to higher abundances of infected orbatid mites in untreated control pastures compared to herbicide treated pastures on the CTER.

T. pisiformis prevalence was similar to historical surveys in Oklahoma by Ward (1934) and Smith (1940). This larval cystercercus was found primarily in the thoracic cavity, mesenteric tissue, and along the pubic symphysis region. T. pisiformis gains access into the rabbit as a result of ingesting infective eggs while foraging. The higher prevalence of T. pisiformis in cottontail populations from burned experimental pastures was unexpected. The CTER supports an abundant population of coyotes (Canis latrans) and it is probable that increased contact of cottontail rabbits with coyotes took place on pastures which were burned. Increased forage value as a result of prescribed burning (Grelen and Epps, 1967) could have increased cottontail rabbit densities, prompting a higher degree of coyote utilization of these habitats. A sparsity of brush and overstory canopies may also have promoted higher coyote utilization of burned pastures. Increased deposition of infective eggs in the habitat would be expected with increased coyote utilization.

Jacobson et al. (1978) reported seasonal influences on

Cittotaenia sp. abundances in cottontail rabbits from Virginia which were similar to this study regarding M. pectinata . Although cestodes were prominant in cottontail populations in both summer and winter on the CTER, Strohlein and Christensen (1983) found M. pectinata in cottontail rabbits only in spring and winter. Differences between seasons and host sex in my study were also consistent with previous surveys of cottontail rabbits in Virginia (Jacobson et al., 1978).

Nematode parasitsm

Prevalence of T. calcaratus infection in cottontail populations on the CTER was higher than previously reported surveys in Oklahoma (Ward, 1934; Smith, 1940) and other southeastern localities (Andrews et al., 1980). Abundance estimates of T. calcaratus were higher than previous studies in Oklahoma (Smith, 1940). Physiological stresses incurred during lactation and pregnancy could have contributed to the observed season and host sex differences in T. calcaratus infections of cottontail rabbits on the CTER. Dunsmore (1966) reported similar seasonal effects for Trichostrongylus retortaeformis in European rabbits (Oryctolagus cuniculus) where infections increased 10 fold in female hosts during the breeding season. The increased abundance of T. calcaratus observed from summer to winter on the CTER was inconsistent with previous surveys of cottontail rabbits in the southeastern U. S. (Andrews et al., 1980; Jacobson et al., 1978).

Oxyurid pinworms, as with T. calcaratus, have a direct life cycle, without intermediate hosts, where infective eggs are transmitted by ingestion (Soulsby, 1982). Prevalence of infection was comparable to the combination of P. ambiguus and D. veligera in southeastern United States (Andrews et al., 1980), lower than the same combination from cottontail rabbits in Alabama (Moore and Moore, 1947), and higher than P. ambiguus and P. nonanulatus in Minnesota (Erickson, 1947). Observed seasonal differences in oxyurid pinworm infections were probably a reflection of both altered intrinsic variables (host behavior, physiological condition) and optimal environmental conditions for survival of infective eggs in spring and summer. Low k values demonstrated that oxyurid pinworms infected relatively few cottontail rabbits with high intensity.

Helminth community

Except for T. pisiformis, helminth distribution in cottontail rabbits inhabiting the CTER was influenced most by season. Intrinsic variables such as host behavior and physiological condition, and extrinsic variables such as temperature and humidity may have contributed to seasonal differences in overdispersion of parasites in cottontail rabbits. However, our study indicates that extrinsic variables such as brush treatment can be as important as intrinsic variables in influencing population dynamics of certain helminth species of the cottontail rabbit. Natural

successional or management-induced modifications of the habitat can potentially alter host-parasite community relationships in a cross timbers ecosystem. Further research efforts may ultimately allow us to accurately predict how various habitat modifications will influence host-parasite relationships. Management of parasitic diseases could become more routine with the availability of such predictive capabilities.

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Figure 1. Forest floor material collected from 5 brush management treatments on the Cross Timbers Experimental Range.

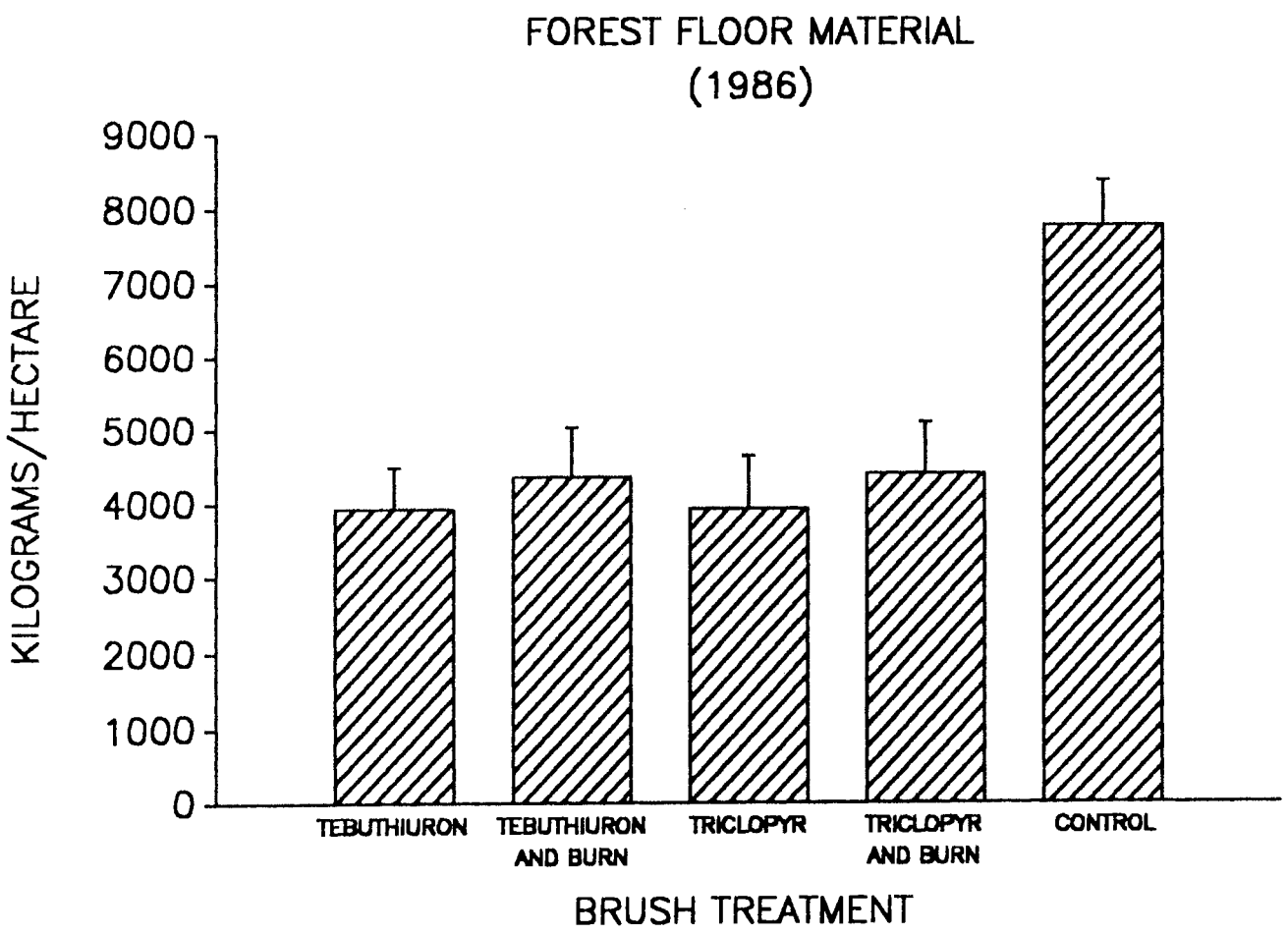
FOREST FLOOR MATERIAL
(1986)
KILOGRAMS/HECTARE
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
TEBUTHIURON
TEBUTHIURON AND BURN
TRICLOPYR
TRICLOPYR AND BURN
CONTROL
BRUSH TREATMENT

Table 1. Prevalence of infection (number infected/number examined) by intestinal helminth parasites recovered from adult cottontail rabbits (n = 88) collected from 5 experimental brush treatments on the Cross Timbers Experimental Range, Payne County, Oklahoma, in winter and summer, 1987.

| | Brush treatment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tebuthiuron | | Tebuthiuron with burn | | Triclopyr | | Triclopyr with burn | | Control | |
| Parasites | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter |
| Nematoda | | | | | | | | | | |
| *Trichostrongylus calcaratus* | 9/9 | 10/10 | 9/9 | 11/11 | 7/8 | 9/9 | 4/5 | 9/10 | 7/7 | 10/10 |
| *Passalurus nonanulatus* | 4/9 | 1/10 | 3/9 | 2/11 | 3/8 | 2/9 | 1/5 | 5/10 | 3/7 | 4/10 |
| *Dermatoxys veligera* | 2/9 | 0/10 | 5/9 | 2/11 | 5/8 | 0/9 | 0/5 | 0/10 | 2/7 | 1/10 |
| *Wellcomia longejector* | 0/9 | 0/10 | 2/9 | 0/11 | 0/8 | 0/9 | 0/5 | 0/10 | 0/7 | 0/10 |
| Pinworms (Total) | 6/9 | 1/10 | 7/9 | 4/11 | 6/8 | 2/9 | 1/5 | 5/10 | 4/7 | 5/10 |
| Cestoda | | | | | | | | | | |
| *Taenia pisiformis*[a] | 6/9 | 9/10 | 8/9 | 10/11 | 5/8 | 6/9 | 5/5 | 8/10 | 4/7 | 9/10 |
| *Mosgovoyia pectinata*[b] | 8/9 | 5/10 | 7/9 | 7/11 | 8/8 | 7/9 | 4/5 | 3/10 | 5/7 | 10/10 |

[a] Significant ($P<0.010$) brush treatment effects for winter specimens

[b] Significant ($P<0.050$) brush treatment effects for summer specimens

Table 2. Mean abundances (standard error) of intestinal helminth parasites of adult male (n = 44) and female (n = 44) cottontail rabbits collected from the Cross Timbers Experimental Range, Payne County, Oklahoma in winter and summer, 1987.

| | Summer | | Winter | |
|---|---|---|---|---|
| Parasites | Male (n = 21) | Female (n = 17) | Male (n = 23) | Female (n = 27) |
| Nematoda | | | | |
| *Trichostrongylus calcaratus* | 117.7 (56.2) | 164.5 (59.8) | 405.9 (58.8) | 313.2 (64.7) |
| *Passalurus nonanulatus* | 453.3 (414.1) | 251.2 (193.1) | 185.7 (99.3) | 249.6 (151.5) |
| *Dermatoxys veligera* | 23.8 (11.6) | 8.2 (3.5) | 1.3 (1.0) | 0.4 (0.4) |
| *Wellcomia longejector* | 4.8 (4.8) | 2.9 (2.9) | 0 | 0 |
| Pinworms (total) | 481.9 (417.8) | 262.4 (196.1) | 187.0 (99.2) | 250.0 (151.4) |
| Cestoda | | | | |
| *Mosgovoyia pectinata* | 3.1 (1.1) | 5.3 (1.4) | 1.0 (0.2) | 0.6 (0.1) |
| *Taenia pisiformis* | 6.4 (1.8) | 22.7 (10.5) | 5.7 (2.0) | 6.1 (1.3) |

Table 3. Mean abundance and intensity data (standard error) for intestinal helminths recovered from 88 adult cottontail rabbits collected in winter and summer, 1987, from 5 experimental brush treatments on the Cross Timbers Experimental Range, Payne County, Oklahoma.

| Brush treatment | | *Trichostrongylus calcaratus* | | *Mosgovoyia pectinata* | | *Taenia pisiformis* | | *Passalurus nonanulatus* | | Pinworms (total) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter |
| Tebuthiuron | A | 90.2 (23.1) | 300.0 (66.7) | 3.0 (1.3) | 0.6 (19.5) | 35.0 (19.5) | 5.4 (1.5) | 78.9 (58.2) | 37.0 (37.0) | 82.2 (57.6) | 37.0 (37.0) |
| | I | 90.2 (23.1) | 300.0 (66.7) | 3.4 (1.4) | 1.2 (0.2) | 52.5 (27.1) | 6.0 (1.5) | 177.5 (120.2) | 370.0 (0.0) | 123.3 ((83.4) | 370.0 (0.0) |
| Tebuthiuron and burn | A | 188.9 (129.8) | 403.3 (70.3) | 4.6 (2.5) | 1.0 (0.4) | 10.1 (2.1) | 5.1 (1.3) | 1060.00 (961.4) | 149.1 (119.5) | 1092.2 (970.0) | 150.9 (118.9) |
| | I | 188.9 (129.8) | 403.3 (70.3) | 5.9 (3.0) | 1.6 (0.4) | 11.4 (1.9) | 5.6 (1.4) | 3180.0 (2778.7) | 820.0 (480.0) | 1404.3 (124.0) | 415.0 (305.0) |
| Triclopyr | A | 96.5 (34.8) | 354.2 (107.2) | 5.9 (2.4) | 0.8 (0.2) | 6.5 (2.7) | 4.3 (2.4) | 418.8 (404.6) | 290.0 (211.5) | 472.5 (405.6) | 290.0 (211.5) |
| | I | 110.3 (36.8) | 354.2 (107.2) | 5.9 (2.4) | 1.0 (0.0) | 10.4 (3.1) | 6.5 (3.3) | 1116.7 (1066.8) | 1305.0 (535.0) | 630.0 (536.0) | 1305.0 (535.0) |
| Triclopyr and burn | A | 272.0 (201.9) | 355.2 (113.1) | 4.4 (2.3) | 0.3 (0.2) | 7.4 (2.1) | 6.5 (2.7) | 2.0 (2.0) | 341.0 (313.5) | 2.0 (2.0) | 31.4 (20.9) |
| | I | 340.0 (245.5) | 394.7 (118.5) | 5.5 (2.6) | 1.0 (0.0) | 7.4 (2.1) | 8.1 (3.2) | 10.0 (0.0) | 682.0 (619.8) | 10.0 (0.0) | 55.0 (33.0) |
| Control | A | 89.1 (22.9) | 361.6 (142.1) | 2.7 (1.0) | 1.4 (0.2) | 3.6 (2.1) | 8.2 (1.9) | 25.7 (20.9) | 298.0 (274.0) | 341.0 (313.5) | 300.0 (273.7) |
| | I | 89.1 (22.9) | 361.6 (142.1) | 3.8 (1.0) | 1.4 (0.2) | 6.3 (3.0) | 9.1 (1.9) | 60.0 (45.1) | 745.0 (672.3) | 682.0 (619.8) | 600.0 (540.6) |

A = Abundance

I = Intensity

Table 4. Determination of overdispersion and measure of degree of aggregation of helminth parasites in cottontail rabbits collected from 5 brush management treatments on the Cross Timbers Experimental Range, Payne County, Oklahoma, based on the frequency distribution of individual parasites recovered from 88 hosts in winter and summer, 1987. k values were derived from Bliss and Fisher, 1953.

| | Brush treatment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tebuthiuron | | Tebuthiuron with burn | | Triclopyr | | Triclopyr with burn | | Control | |
| Parasites | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter |
| Nematoda | | | | | | | | | | |
| *Trichostrongylus calcaratus* | 1.70* | 2.04 | 0.24* | 3.01 | 0.97* | 0.99 | 0.36* | 0.99* | 2.22* | 0.65* |
| *Passalurus nonanulatus* | 0.21* | 0.10* | 0.14* | 0.14* | 0.13* | 0.21* | 0.22* | 0.12* | 0.22* | 0.12* |
| *Dermatoxys veligera* | 0.24* | ---- | 0.84* | 0.13* | 0.47* | ---- | ---- | ---- | 0.27* | 0.11* |
| *Wellcomia longejector* | ---- | ---- | 0.23* | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| Pinworms | 0.23* | 0.10* | 0.14* | 0.15* | 0.17* | 0.21* | 0.22* | 0.12* | 0.33* | 0.12* |
| Cestoda | | | | | | | | | | |
| *Taenia pisiformis* | 0.36* | 1.83 | 3.58* | 1.83 | 0.85* | 0.40* | 3.68* | 0.62* | 0.50* | 2.35* |
| *Mosgovoyia pectinata* | 0.75* | 3.24 | 0.42* | 2.50 | 0.87* | 1.04* | 0.86* | 1.50 | 1.91* | 1.73 |

* Variance is significantly ($P \leq 0.05$) larger than the mean abundance.

# CHAPTER III

## HELMINTH COMMUNITY ECOLOGY IN COTTON RATS (*SIGMODON HISPIDUS*) AS INFLUENCED BY HABITAT MODIFICATION IN THE CROSS TIMBERS OF OKLAHOMA

**ABSTRACT:** Dynamics of gastrointestinal helminth communities of cotton rat (Sigmodon hispidus) populations were monitored in response to 5 experimental brush management treatments using prescribed burning and herbicide applications on the Cross Timbers Experimental Range in Payne County, Oklahoma. A total of 113 adult cotton rats (68 male and 45 female) was collected from experimental pastures in winter and summer 1986, resulting in the recovery of 5 helminth species: Longistriata adunca, Syphacia sigmodontis, Strongyloides sp., Protospirura muris, and Raillietina sp. Prevalence and abundance of Raillietina sp. and abundance of S. sigmodontis were significantly lower on annually burned pastures compared to unburned pastures. Abundance of L. adunca also showed a significant treatment by season interaction. Abundances of L. adunca in cotton rats decreased from winter to summer on annually burned pastures while increasing on other pastures. Cotton rats from control pastures had higher prevalences of Raillietina sp. in winter and S. sigmodontis in both summer and winter than did brush-treated pastures. Distribution of all helminths was overdispersed. Distribution of L. adunca showed a significant brush treatment by season interaction as a result of greater overdispersion in summer than winter for cotton rats inhabiting brush-treated pastures. These results indicate that man-induced habitat modifications can alter host-parasite relationships in the community.

Key words: Cotton rat, Sigmodon hispidus, Habitat modification, parasitism, helminths, brush management, tebuthiuron, triclopyr, prescribed burning.

## INTRODUCTION

A great amount of geographical variation exists in the composition of helminth communities harbored by a particular host population (Pence et al., 1983; Andrews et al., 1980). Most of this geographic variation is thought to be due to differences in extrinsic habitat variables, including both abiotic and biotic components (Kinsella, 1974; Mollhagen, 1978; Martin and Huffman, 1980). However, habitat factors vary not only across the geographic range of a host species but also across time within the habitat of a resident population. Man-induced and natural successional changes commonly occur, potentially altering a variety of abiotic and biotic characteristics of the habitat.

Few studies have examined the influences of local habitat changes on the dynamics of helminth communities of resident host populations. Issac (1963) and Bendell (1974) reported changes in helminth communities of blacktailed deer (Odocoileus hemionus columbianus) and blue grouse (Dendragopus obscurus), respectively, following wildfires. Similarly, Seip and Bunnell (1985) noted reductions in Protostrongylus sp. in Stone's sheep (Ovis dalli stonei) utilizing annually burned alpine ranges.

Cotton rats (Sigmodon hispidus) are important small

mammal components of the cross timbers ecosystem in central Oklahoma. Herbicide applications and prescribed burning are commonly used techniques for improving livestock grazing potential on brush-infested rangelands in the cross timbers region. These brush management strategies typically result in dramatic alterations in both habitat structure and composition (Scifres, 1980). I used the cotton rat as an animal model for evaluating the potential impact of these brush management strategies on helminth community dynamics in the cross timbers of Oklahoma. Specifically, I examined the influences of herbicide and fire applications on the distribution, abundance, prevalence, and species richness of gastrointestinal helminths of the cotton rat.

## MATERIALS AND METHODS

### Study area

This study was conducted on the Cross Timbers Experimental Range (CTER) which is located approximately 11 km west of Stillwater, Oklahoma in Payne County. The CTER is a 648-ha research area composed of blackjack oak (*Quercus marilandica*)-post oak (*Q. stellata*) savannas intermixed with eastern redcedar (*Juniperus virginiana*) and prairies of short and tall grasses (Ewing et al., 1984). The CTER includes 20 32.4-ha (0.42 km x 0.83 km) fenced experimental pastures, representing 4 replications of 4 brush management treatments, using combinations of herbicide and annual prescribed burning applications, and an untreated control

(Appendix D). This provides a 2 x 2 factorial experimental design of 4 replications of 5 treatments. The 5 experimental treatments include: (1) tebuthiuron (N-[5-(1,1-dimethyl-ethyl)-1,3,4-thiadiazol-2 yl]-N,N'-dimethylurea), a soil-applied herbicide (Elanco Products Co., Division of Eli Lilly and Co., Indianapolis, Indiana 46285), applied aerially at 2.2 kg per ha in March 1983; (2) tebuthiuron applied (as with treatment #1) with annual prescribed burning in April, beginning in 1985; (3) triclopyr ([(3,5,6-trichloro-2-pyridinyl) oxy] acetic acid), a foliage applied herbicide (Dow Chemical Co., Midland, Michigan 48674), applied aerially at 2.2 kg per ha in June 1983; (4) triclopyr applied (as with #3) with annual prescribed burning in April, beginning in 1985; (5) untreated control. All experimental pastures were moderately grazed by cattle throughout spring and summer.

Herbicide-treated pastures produced more grasses and forbs compared to untreated control pastures (Engle et al., 1987). Both herbicides killed a high proportion of the dominant overstory oak species, but woody understory species such as buckbrush (Symphoricarpos orbiculatus), elm (Ulmus americana), and chittamwood (Bumelia lanuginosa) were not reduced as much by triclopyr as by tebuthiuron (Stritzke et al., 1987). Competition with understory woody species reduced the production of herbaceous plants after triclopyr treatment.

Data collection

Cotton rats were collected from the CTER from July to September 1986 (summer) and December 1986 to January 1987 (winter). Due to extremely low densities of cotton rats on experimental control pastures in winter on the CTER, I also collected animals from untreated cross timbers rangeland on nearby (within 2.5 km) research lands to serve as controls. Cotton rats were sampled by removal snap-trapping using a randomly placed 8 X 8 transect grid with 15 meter spacing between trap stations within each pasture. Snap traps were baited with a peanut butter-rolled oats mixture and apples for 3 consecutive days. Cotton rats were frozen immediately after collection and later necropsied and eviscerated as time allowed. Eviscerated intestinal contents were sieved with a 150 micron filter and diluted 10 or 50%, depending upon volume of contents, for enumeration of nematodes. Total recovery of tapeworms and stomach worms was attempted.

Nematodes were stored in 70% ethanol and examined in lactophenol wetmounts. Cestodes were fixed in acetic acid-formalin ethyl alcohol, stained in Carmine and mounted in permount. Representative samples of helminths recovered from this study have been deposited in the U. S. National Parasite Collection, Beltsville, Maryland 20705, U.S.A. (Accession nos. 80566-80570).

Data analysis

The terms abundance, intensity and prevalence are defined by Margolis et al. (1982). Only adult cotton rats ($n$ = 113) were used for helminth recovery and all available

hosts were examined, resulting in a data set of 113 specimens. No analysis for Protospirura muris abundance data was performed due to low prevalence.

Overdispersion is defined by Bliss and Fisher (1953) and is used to describe the frequency distributions of common (>15% prevalence) helminth species where a small number of host individuals harbor many individual parasites of a particular helminth species (Waid et al., 1985; Corn et al., 1985). Overdispersion is indicated when helminth frequency distributions revealed a variance significantly larger ($P \leq 0.050$) than the mean abundance using a chi-square distribution. The degree of overdispersion was measured by the negative binomial parameter k (Bliss and Fisher, 1953) which is an inverse measure of the degree of overdispersion. Differences in overdispersion (k) among brush treatments and seasons were then evaluated by analysis of variance using Anscombe's transform, $Log_{10}(x + 1/2k)$, of abundance data (Bliss and Owen, 1958). Overdispersed helminth abundances for the 113 sample data set were independently rank transformed (Conover and Iman, 1981; PROC RANK, Statistical Analysis Systems, 1985, SAS Institute, Raleigh, North Carolina) for each common parasite species prior to data analysis as a method to analyze non-normally distributed data (Conover and Iman, 1981; Waid et al., 1985).

The main and interactive effects of treatment, season and sex were examined with a factorial analysis of variance

and multivariate analysis of variance (MANOVA) for the ranked abundances of recovered helminth species (PROC GLM, SAS). Apriori specific contrasts were used to compare variation among brush treatment components (burned vs. unburned, tebuthiuron vs. triclopyr and control vs. treatment). Protected multiple comparisons (LSD) were used when significant differences ($P < 0.100$) were detected by analysis of variance. Prevalence was subjected to chi-square analysis for determination of heterogeneity between brush treatments and seasons. Statistical significance is set at $P \leq 0.100$ Copies of the raw and rank transformed data are available upon request from Robert L. Lochmiller.

## RESULTS

### Species richness

Four nematodes (Longistriata adunca Chandler, 1932; Strongyloides sp. Grassi, 1879; P. muris Gmelin, 1790; Syphacia sigmodontis Quentin and Kinsella, 1972) and one cestode (Raillietina sp. Fuhrmann, 1920) were recovered from 113 (68 male and 45 female) cotton rats (Table 1). All four helminth species were recovered from cotton rats collected from control and annually burned tebuthiuron pastures, and these were the only treatments from which P. muris was recovered. Syphacia sigmodontis was not recovered from cotton rats in annually burned triclopyr treatments. Raillietina sp., L. adunca, and Strongyloides sp. were recovered from cotton rat populations on all brush

treatments.

Prevalence

Prevalence of S. sigmodontis and Raillietina sp. infections in cotton rat populations were significantly ($P < 0.050$) influenced by experimental brush treatments (Table 2). Prevalence of S. sigmodontis infection was greater ($P < 0.050$) in populations from control (38.5%) than treated (14.0%) pastures. Prevalence of Raillietina sp. infections was greater ($P < 0.050$) on control (53.8%) than brush treated (26.0%) pastures and greater ($P < 0.005$) on tebuthiuron (34.0%) than triclopyr-treated (18.9%) pastures. Cotton rat populations from unburned experimental treatments (40.0%) also had a greater ($P < 0.005$) prevalence of Raillietina sp. infection than those collected from burned (14.6%) pastures.

Prevalence of P. muris was high in cotton rats collected from control pastures in winter (62.5%); only one cotton rat from brush-treated habitat (annually burned tebuthiuron) was infected with P. muris. Brush treatments had no significant influence ($P > 0.100$) on the prevalence of Strongyloides sp. in cotton rat populations. However, prevalence was affected by season, being greater ($P < 0.050$) in winter (29.3%) than summer (21.8%). Prevalences of other helminths were not significantly ($P > 0.100$) affected by season.

Helminth abundance and intensity

Mean rank abundances of Raillietina sp. were

significantly ($P < 0.001$) affected by brush treatment. Cotton rats collected from unburned pastures had lower ($P < 0.001$) abundances of Raillietina sp. compared to burned pastures (Table 3). Mean rank abundances of Raillietina sp. were also greater ($P < 0.043$) in cotton rats from tebuthiuron-treated than triclopyr-treated pastures. Abundances of Raillietina sp. were not different ($P > 0.100$) between control and brush-treated pastures. Abundance of Raillietina sp. was also influenced by host sex, being greater ($P < 0.039$) in male than female cotton rats. Season had no influence ($P > 0.100$) on the abundance of Raillietina sp. in cotton rats.

Mean rank abundance of S. sigmodontis differed significantly ($P < 0.005$) among brush treatments as well. Abundances of S. sigmodontis were greater ($P < 0.016$) for cotton rats collected from unburned than burned pastures. Abundances of S. sigmodontis were also greater ($P < 0.012$) for cotton rats obtained from control pastures compared to brush treated pastures. A treatment by season interaction ($P < 0.056$) indicated that abundance of S. sigmodontis in cotton rats from herbicide-treated pastures decreased from winter to summer, while the reverse was true for cotton rats from control pastures. There was no significant ($P > 0.100$) difference in abundances between seasons or host sexes for this parasite. Triclopyr-treated pastures had significantly greater ($P < 0.016$) abundances than tebuthiuron-treated pastures. A significant ($P < 0.001$) treatment by season

interaction was indicated as abundances of L. adunca from winter to summer decreased in cotton rat populations from annually burned pastures while inreasing for those from unburned pastures. No significant ($P > 0.100$) differences in abundances of L. adunca were found between host sexes or seasons.

Abundance of Strongyloides sp. was not significantly affected by brush treatment ($P > 0.456$), season ($P > 0.773$), or host sex ($P > 0.774$). Mean abundance of P. muris infection was $2.6 \pm 1.0$ worms per host in control pastures in winter. Only one cotton rat was found infected with P. muris (collected from an annually burned tebuthiuron pasture) in summer.

Helminth Distribution

All parasites indicated a high ($k \leq 0.10$) degree of overdispersion (clumping) throughout the year across all treatments. Analysis of distribution (k) data was only performed on Strongyloides sp. and L. adunca; distributions of other helminths were not suitable for statistical analysis (table 4). Overdispersion of Strongyloides sp. was not significantly affected by host sex ($P > 0.815$), season ($P > 0.965$), or brush treatment ($P > 0.686$). However, distribution of Strongyloides sp. did show a significant ($P < 0.004$) treatment by season interaction. Overdispersion of Strongyloides sp. in cotton rat populations from triclopyr-treated pastures was greater in winter than summer, while the reverse was true for cotton rats from tebuthiuron-

public relations programs that provides hard, meaningful evidence of the effect of the programs. This does not mean counting press clippings or documenting media coverage of a promotional event... (it) means translating the work and effect of programs into sales, market share, and measurable community awareness. It is imperative that college public relations curriculums develop required courses on the use of research in public relations. If not, the marketing profession will swallow up public relations in the next 10-15 years."

Respondents were also asked to add any additional comments they might have. Most of the comments given were directed to the author and were of no relevance to this study.

## Relationships Between Respondent Characteristics and Respondent Rankings

Responses to questions concerning the type of public relations organization respondents worked for, type of education, and years of public relations experience were analyzed to determine if any unusual interaction occurred between these variables.

### Public Relations Organization and Education

Of the respondents who categorized themselves as working in corporate public relations, the largest number, 15 percent, had earned a degree in print/broadcast journalism.

The second largest percentage grouping earned a degree in public relations and were currently working for a public relations agency.

There were no respondents who both worked in the field of public relations education with a degree in business, nor were there any respondents who both worked for the government and earned a degree in the "other" category. Table XII cross references practitioners' public relations organization by their education.

TABLE XII

RESPONDENTS' EDUCATION AND PUBLIC RELATIONS AREA OF WORK

| Organization | N | Education | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | PR | | Journalism | | Business | | Other | |
| | | N | % | N | % | N | % | N | % |
| Agency | 37 | 7 | (4.9) | 16 | (11.3) | 4 | (2.8) | 10 | (7.0) |
| Non-Profit | 21 | 7 | (4.9) | 6 | (4.2) | 2 | (1.4) | 6 | (4.2) |
| Government | 6 | 1 | (0.7) | 3 | (2.1) | 2 | (1.4) | 0 | (0.0) |
| Corporate | 46 | 9 | (6.3) | 22 | (15.5) | 4 | (2.8) | 11 | (7.8) |
| Business | 7 | 1 | (0.7) | 4 | (2.8) | 1 | (0.7) | 1 | (0.7) |
| Education | 13 | 1 | (0.7) | 6 | (4.2) | 0 | (0.0) | 6 | (4.2) |
| Other | 12 | 2 | (1.4) | 5 | (3.5) | 2 | (1.4) | 3 | (2.1) |
| TOTALS | 142 | 28 | 19.6* | 62 | 43.6* | 15 | 10.5* | 37 | 26.0* |

(* Percentages do not equal 100 due to computer rounding.)

Public Relations Organization and Experience

The largest number of public relations professionals in this grouping have over 15 years of experience and work for a corporation. The second highest percentage in this grouping work for an agency and have over 15 years of experience. It seemed unusual that those respondents who worked in the field of business had either six to ten years of experience (one percent) or over 15 years of

experience (four percent).

There were no respondents in the field of business public relations who had zero to five years of experience or who had 11-15 years of experience. Table XIII cross references practitioners' public relations organization by their experience.

TABLE XIII

RESPONDENTS' PUBLIC RELATIONS AREA OF WORK AND EXPERIENCE

| Organization | N | Experience | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0-5 | | 6-10 | | 11-15 | | 15+ | |
| | | N | % | N | % | N | % | N | % |
| Agency | 37 | 5 | (3.6) | 9 | (6.3) | 7 | (4.9) | 16 | (11.3) |
| Non-Profit | 21 | 7 | (4.9) | 5 | (3.5) | 1 | (0.7) | 8 | (5.6) |
| Government | 6 | 1 | (0.7) | 1 | (0.7) | 1 | (0.7) | 3 | (2.1) |
| Corporate | 46 | 6 | (4.2) | 6 | (4.2) | 10 | (7.0) | 24 | (16.9) |
| Business | 7 | 0 | (0.0) | 2 | (1.4) | 0 | (0.0) | 5 | (3.5) |
| Education | 13 | 2 | (1.4) | 3 | (2.1) | 4 | (2.8) | 4 | (2.8) |
| Other | 12 | 3 | (2.1) | 1 | (0.7) | 2 | (1.4) | 6 | (4.2) |
| TOTALS | 142 | 24 | 16.9* | 27 | 18.9* | 25 | 17.5* | 66 | 46.4* |

(* Percentages do not equal 100 due to computer rounding.)

Public Relations Organization and Test

The only type of public relations organization which said it gave tests more often than not to applicants was the respondents in the field of business public relations. In all other types of public relations organizations, the number who did not give tests to applicants was greater than those who did. Table XIV cross references practitioners' public relations organization by whether

their organization gives applicants a written exam.

TABLE XIV

WHETHER APPLICANTS ARE GIVEN A WRITTEN TEST BY PUBLIC RELATIONS ORGANIZATIONS

| Organization | N | Yes | | No | |
|---|---|---|---|---|---|
| | | N | % | N | % |
| Agency | 37 | 17 | (12.0) | 20 | (14.1) |
| Non-Profit | 21 | 7 | (4.9) | 14 | (9.9) |
| Government | 6 | 3 | (2.1) | 3 | (2.1) |
| Corporate | 46 | 19 | (13.4) | 27 | (19.0) |
| Business | 7 | 4 | (2.8) | 3 | (2.1) |
| Education | 13 | 5 | (3.5) | 8 | (5.6) |
| Other | 12 | 4 | (2.8) | 8 | (5.6) |
| TOTALS | 142 | 59 | 41.5* | 83 | 58.4* |

(* Percentages do not equal 100 due to computer rounding.)

Respondents' Education and Experience

Of the respondents with over 15 years of experience, 23 percent indicated they earned a degree in print/broadcast journalism. In fact, a degree in journalism scored the highest in every age group. Those who received their degree in public relations and had between 0-5 years of experience came in a close second to a degree in journalism. Possibly this is an indication of the increased importance being placed on a public relations degree.

The fact that older practitioners earned a degree in journalism more than any other field does not seem unusual since journalism was once, and to some extent still is,

thought of as the preferred training for the public relations professional.

There does, however, seem to be a shortage in the number of public relations professionals who have 11-15 years of experience who earned a degree in either pubic relations or business (one percent each). Perhaps this is due to the fact that until recently business majors were thought to lack the writing skills needed for public relations and the public relations curriculum was seen to be inferior to a journalism degree. Table XV cross references practitioners' public relations education by their experience.

TABLE XV

EDUCATION AND EXPERIENCE OF RESPONDENTS

| Degree | N | Years of Experience | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0-5 | | 6-10 | | 11-15 | | 15+ | |
| | | N | % | N | % | N | % | N | % |
| Public Relations | 28 | 9 | (6.3) | 6 | (4.2) | 2 | (1.4) | 11 | (7.8)* |
| Journalism | 62 | 8 | (5.6) | 10 | (7.0) | 12 | (8.5) | 32 | (22.5) |
| Business | 15 | 4 | (2.8) | 2 | (1.4) | 2 | (1.4) | 7 | (4.9) |
| Other | 37 | 3 | (2.1) | 9 | (6.3) | 9 | (6.3) | 16 | (11.3) |
| TOTALS | 142 | 24 | 16.8** | 27 | 18.9** | 25 | 17.6** | 66 | 46.5** |

(* Of those respondents who indicated two degrees, the most recent degree attained was used for this study.)

(** Percentages do not equal 100 due to computer rounding.)

## Public Relations Course Rankings and Respondents' Area of Work

The field of public relations is diverse and the training needed for each aspect of public relations work varies from organization to organization. All of the organizations studied ranked newswriting as the top course. The only other course which appeared somewhere in all of the organizations' rankings was public relations lab.

Only those respondents who indicated they worked in government public relations ranked mass communication law in the top five. The course visual communication was ranked in the top five only by those who worked in government public relations or the category "other," and in both instances visual communication was ranked as the last choice. Table XVI cross references practitioners' rankings of public relations courses by their area of work.

TABLE XVI

RANKING OF PUBLIC RELATIONS COURSES BY RESPONDENTS' AREA OF WORK

| Ranking | Organization | Course | N | Percent |
|---|---|---|---|---|
| | AGENCY | | | |
| 1. | | News writing | 13 | 9.2 |
| 2. | | News editing | 10 | 7.0 |
| 3. | | PR principles | 8 | 5.6 |
| | | PR lab | 8 | 5.6 |
| 4. | | PR programs | 11 | 7.8 |

TABLE XVI (Continued)

| | | | | |
|---|---|---|---|---|
| 5. | | PR programs | 8 | 5.6 |
| | NON-PROFIT | | | |
| 1. | | Newswriting | 9 | 6.3 |
| 2. | | News editing | 6 | 4.2 |
| 3. | | PR lab | 5 | 3.5 |
| | | PR programs | 6 | 4.2 |
| 4. | | PR media | 4 | 2.8 |
| 5. | | PR principles | 4 | 2.8 |
| | | PR lab | | |
| | GOVERNMENT | | | |
| 1. | | Newswriting | 3 | 2.1 |
| 2. | | Newswriting | 2 | 1.4 |
| | | PR lab | 2 | 1.4 |
| 3. | | Case studies | 1 | 0.7 |
| | | Communication law | 1 | 0.7 |
| | | PR principles | 1 | 0.7 |
| | | PR lab | 1 | 0.7 |
| | | PR media | 1 | 0.7 |
| | | Visual communication | 1 | 0.7 |
| 4. | | Case studies | 2 | 1.4 |
| 5. | | Visual communication | 2 | 1.4 |
| | CORPORATE | | | |
| 1. | | Newswriting | 22 | 15.5 |
| 2. | | Newswriting | 17 | 11.9 |
| | | PR lab | 17 | 11.9 |
| 3. | | PR media | 10 | 7.0 |
| 4. | | Case studies | 11 | 7.8 |
| 5. | | PR lab | 13 | 2.1 |
| | BUSINESS | | | |
| 1. | | Newswriting | 4 | 2.8 |
| 2. | | Newswriting | 2 | 1.4 |
| 3. | | PR principles | 3 | 2.1 |
| 4. | | PR programs | 2 | 1.4 |
| 5. | | PR lab | 3 | 2.1 |
| | EDUCATION | | | |
| 1. | | Newswriting | 5 | 3.5 |
| | | PR principles | 5 | 3.5 |
| 2. | | Case studies | 4 | 2.8 |
| | | Newswriting | 4 | 2.8 |
| 3. | | PR programs | 5 | 3.5 |
| 4. | | PR lab | 4 | 2.8 |
| 5. | | Case studies | 4 | 2.8 |
| | OTHER | | | |
| 1. | | Newswriting | 7 | 4.9 |
| 2. | | Newswriting | 5 | 3.5 |
| 3. | | PR lab | 3 | 2.1 |
| 4. | | Case studies | 3 | 2.1 |
| 5. | | PR media | 3 | 2.1 |
| | | Visual communication | 3 | 2.1 |

## Business Course Rankings and Respondents' Area of Work

Every organization except for the category other ranked marketing as the top business course for the public relations curriculum. The category other ranked marketing as second, behind management. Marketing was the second most preferred course. Accounting was the last choice for all organizations. Table XVII cross references practitioners' rankings of business courses by their area of work.

TABLE XVII

RANKING OF BUSINESS COURSES BY RESPONDENTS' AREA OF WORK

| Ranking | Organization | Course | N | Percent |
|---|---|---|---|---|
| | AGENCY | | | |
| 1. | | Marketing | 27 | 19.0 |
| 2. | | Management | 27 | 19.0 |
| 3. | | Finance | 15 | 10.6 |
| 4. | | Accounting | 13 | 9.1 |
| 5. | | Accounting | 16 | 11.3 |
| | NON-PROFIT | | | |
| 1. | | Marketing | 14 | 9.9 |
| 2. | | Management | 10 | 7.0 |
| 3. | | Finance | 8 | 5.6 |
| 4. | | Economics | 7 | 4.9 |
| | | Finance | 7 | 4.9 |
| 5. | | Accounting | 12 | 8.5 |
| | GOVERNMENT | | | |
| 1. | | Marketing | 2 | 1.4 |
| | | Management | 2 | 1.4 |
| 2. | | Marketing | 4 | 2.8 |
| 3. | | Finance | 3 | 2.1 |
| 4. | | Economics | 3 | 2.1 |
| 5. | | Accounting | 5 | 3.5 |
| | CORPORATE | | | |
| 1. | | Marketing | 20 | 14.1 |

TABLE XVII (Continued)

| | | | | |
|---|---|---|---|---|
| 2. | | Management | 15 | 10.6 |
| 3. | | Economics | 11 | 7.8 |
| 4. | | Finance | 19 | 13.4 |
| 5. | | Accounting | 24 | 16.9 |
| | BUSINESS | | | |
| 1. | | Marketing | 3 | 2.1 |
| | | Economics | 3 | 2.1 |
| 2. | | Management | 4 | 2.8 |
| 3. | | Finance | 3 | 2.1 |
| 4. | | Accounting | 3 | 2.1 |
| | | Finance | 3 | 2.1 |
| 5. | | Accounting | 4 | 2.8 |
| | EDUCATION | | | |
| 1. | | Marketing | 10 | 7.0 |
| 2. | | Management | 9 | 6.3 |
| 3. | | Economics | 5 | 3.5 |
| 4. | | Finance | 8 | 5.6 |
| 5. | | Accounting | 9 | 6.3 |
| | OTHER | | | |
| 1. | | Management | 4 | 2.8 |
| 2. | | Marketing | 5 | 3.5 |
| 3. | | Accounting | 4 | 2.8 |
| | | Economics | 4 | 2.8 |
| 4. | | Finance | 5 | 3.5 |
| | | Management | 5 | 3.5 |
| 5. | | Accounting | 6 | 4.2 |

## Extra-Curricular Activities Rankings and Respondents' Area of Work

A public relations internship was the top activity in all organizations except for government public relations, which ranked it as the second most important. Other preferred activities included volunteer work with a public relations organization and reporter for school paper. Table XVIII cross references practitioners' rankings of extra-curricular activities by their area of work.

TABLE XVIII

RANKING OF EXTRA-CURRICULAR ACTIVITIES BY RESPONDENTS' AREA OF WORK

| Ranking | Organization | Activity | N | Percent |
|---|---|---|---|---|
| | AGENCY | | | |
| 1. | | PR internship | 18 | 12.7 |
| 2. | | Volunteer | 12 | 8.5 |
| 3. | | Volunteer | 11 | 7.8 |
| 4. | | PRSSA member | 12 | 8.5 |
| 5. | | Non-PR work | 18 | 12.7 |
| | NON-PROFIT | | | |
| 1. | | PR internship | 11 | 7.8 |
| 2. | | PR internship | 7 | 4.9 |
| | | Volunteer | 7 | 4.9 |
| 3. | | Reporter | 9 | 6.4 |
| 4. | | Non-PR work | 8 | 5.6 |
| 5. | | Non-PR work | 6 | 4.2 |
| | | PRSSA member | 6 | 4.2 |
| | | Scholarship/grants | 6 | 4.2 |
| | GOVERNMENT | | | |
| 1. | | Reporter | 3 | 2.1 |
| 2. | | PR internship | 2 | 1.4 |
| | | Volunteer | 2 | 1.4 |
| 3. | | Volunteer | 2 | 1.4 |
| 4. | | Scholarships/grants | 3 | 2.1 |
| 5. | | Non-PR work | 3 | 2.1 |
| | CORPORATE | | | |
| 1. | | PR internship | 19 | 13.4 |
| 2. | | PR internship | 16 | 11.3 |
| 3. | | Volunteer | 18 | 12.7 |
| 4. | | PRSSA member | 13 | 9.2 |
| 5. | | PRSSA member | 14 | 9.9 |
| | | Scholarships/grants | 14 | 9.9 |
| | BUSINESS | | | |
| 1. | | PR internship | 3 | 2.1 |
| | | Reporter | 3 | 2.1 |
| 2. | | Volunteer | 3 | 2.1 |
| 3. | | PR internship | 2 | 1.4 |
| | | Reporter | 2 | 1.4 |
| 4. | | PRSSA member | 2 | 1.4 |
| | | Volunteer | 2 | 1.4 |
| 5. | | PRSSA member | 3 | 2.1 |
| | EDUCATION | | | |
| 1. | | PR internship | 8 | 5.6 |
| 2. | | Volunteer | 7 | 4.9 |
| 3. | | Reporter | 6 | 4.2 |
| 4. | | PRSSA member | 5 | 3.5 |
| 5. | | Scholarships/grants | 5 | 3.5 |

TABLE XVIII (Continued)

| | | | |
|---|---|---|---|
| | OTHER | | |
| 1. | PR internship | 5 | 3.5 |
| | Reporter | 5 | 3.5 |
| 2. | Volunteer | 4 | 2.8 |
| 3. | PR internship | 4 | 2.8 |
| | Reporter | 4 | 2.8 |
| 4. | Volunteer | 5 | 3.5 |
| 5. | Scholarships/grants | 5 | 3.5 |

Public Relations Course Rankings and Respondents' Education

Also of interest was how respondents ranked courses and activities with respect to their individual educational backgrounds. It was not surprising to find that respondents who earned a degree in either public relations or journalism ranked newswriting as the top course. Both business and other majors preferred the course principles of public relations as the top choice. Table XVIV cross references practitioners' rankings of public relations courses by their education.

TABLE XIX

RANKING OF PUBLIC RELATIONS COURSES BY RESPONDENTS' EDUCATION

| Ranking | Education | Course | N | Percent |
|---|---|---|---|---|
| | PUBLIC RELATIONS | | | |
| 1. | | Newswriting | 11 | 7.8 |
| 2. | | Newswriting | 9 | 6.3 |
| 3. | | PR lab | 7 | 4.9 |
| 4. | | PR media | 8 | 5.6 |
| 5. | | PR programs | 7 | 4.9 |

TABLE XIX (Continued)

| | | | | |
|---|---|---|---|---|
| | JOURNALISM | | | |
| 1. | | Newswriting | 40 | 28.2 |
| 2. | | News editing | 26 | 18.3 |
| 3. | | PR principles | 15 | 10.6 |
| 4. | | PR programs | 14 | 9.9 |
| 5. | | Case studies | 14 | 9.9 |
| | BUSINESS | | | |
| 1. | | PR principles | 6 | 4.3 |
| 2. | | PR programs | 4 | 2.8 |
| 3. | | Case studies | 3 | 2.1 |
| | | Newswriting | 3 | 2.1 |
| | | PR lab | 3 | 2.1 |
| 4. | | Newswriting | 4 | 2.8 |
| 5. | | PR principles | 3 | 2.1 |
| | | PR media | 3 | 2.1 |
| | OTHER | | | |
| 1. | | PR principles | 14 | 9.9 |
| 2. | | Case studies | 8 | 5.6 |
| | | Newswriting | 8 | 5.6 |
| 3. | | Newswriting | 6 | 4.2 |
| | | PR media | 6 | 4.2 |
| | | PR programs | 6 | 4.2 |
| 4. | | PR principles | 7 | 4.9 |
| 5. | | PR lab | 12 | 8.5 |

## Business Course Rankings and Respondents' Education

Marketing was the top business course for all types of educational background. Management was second. Again, all chose accounting as the least recommended course for the public relations major. Table XX cross references practitioners' rankings of business courses by their education.

TABLE XX

RANKING OF BUSINESS COURSES BY RESPONDENTS' EDUCATION

| Ranking | Education Course | | N | Percent |
|---|---|---|---|---|
| | PUBLIC RELATIONS | | | |
| 1. | | Marketing | 19 | 13.4 |
| 2. | | Management | 14 | 9.9 |
| 3. | | Economics | 9 | 6.3 |
| | | Finance | 9 | 6.3 |
| 4. | | Accounting | 9 | 6.3 |
| 5. | | Accounting | 9 | 6.3 |
| | JOURNALISM | | | |
| 1. | | Marketing | 29 | 20.4 |
| 2. | | Marketing | 24 | 16.9 |
| 3. | | Finance | 17 | 12.0 |
| 4. | | Finance | 23 | 16.2 |
| 5. | | Accounting | 36 | 25.4 |
| | BUSINESS | | | |
| 1. | | Marketing | 10 | 7.0 |
| 2. | | Management | 8 | 5.6 |
| 3. | | Finance | 5 | 3.5 |
| 4. | | Economics | 6 | 4.2 |
| 5. | | Accounting | 8 | 5.6 |
| | OTHER | | | |
| 1. | | Marketing | 21 | 14.8 |
| 2. | | Management | 23 | 16.2 |
| 3. | | Economics | 14 | 9.9 |
| 4. | | Finance | 18 | 12.7 |
| 5. | | Accounting | 23 | 16.2 |

Extra-Curricular Activities Rankings and Respondents' Education

Educational background was not a factor in chosing the top extra-curricular activity for the public relations student. A public relations internship was the most recommended, with volunteer work with a public relations organization coming in second. Table XXI cross references practitioners' rankings of extra-curricular activities by

their education.

TABLE XXI

RANKING OF EXTRA-CURRICULAR ACTIVITIES BY RESPONDENTS' EDUCATION

| Ranking | Education Activity | | N | Percent |
|---|---|---|---|---|
| | PUBLIC RELATIONS | | | |
| 1. | | PR internship | 14 | 9.9 |
| 2. | | PR internship | 9 | 6.3 |
| 3. | | Volunteer | 11 | 7.8 |
| 4. | | PRSSA member | 12 | 8.5 |
| 5. | | Scholarships | 10 | 7.0 |
| | JOURNALISM | | | |
| 1. | | PR internship | 26 | 18.3 |
| 2. | | PR internship | 19 | 13.4 |
| | | Volunteer | 19 | 13.4 |
| 3. | | Volunteer | 21 | 14.8 |
| 4. | | Reporter | 18 | 12.7 |
| 5. | | Non-PR work | 21 | 14.8 |
| | BUSINESS | | | |
| 1. | | PR lab | 8 | 5.6 |
| 2. | | Volunteer | 6 | 4.2 |
| 3. | | PRSSA member | 6 | 4.2 |
| 4. | | Reporter | 4 | 2.8 |
| 5. | | PRSSA member | 5 | 3.5 |
| | | Scholarships/grants | 5 | 3.5 |
| | OTHER | | | |
| 1. | | PR lab | 18 | 12.7 |
| 2. | | Volunteer | 12 | 8.5 |
| 3. | | PRSSA member | 10 | 7.0 |
| 4. | | Non-PR work | 8 | 5.6 |
| | | PRSSA member | 8 | 5.6 |
| | | Volunteer | 8 | 5.6 |
| 5. | | Scholarships/grants | 11 | 7.8 |

## Public Relations Course Rankings and Respondents' Experience

When ranking the top public relations course, the number of years of experience a respondent had was not a factor. Newswriting was the top choice for all categories

of experience. News editing was the second most preferred course. Table XXII cross references practitioners' rankings of public relations courses by their experience.

TABLE XXII

RANKING OF PUBLIC RELATIONS COURSES BY RESPONDENTS' EXPERIENCE

| Ranking | Experience | Course | N | Percent |
|---|---|---|---|---|
| | 0-5 YEARS | | | |
| 1. | | Newswriting | 11 | 7.8 |
| 2. | | News editing | 9 | 6.3 |
| 3. | | PR lab | 8 | 5.6 |
| 4. | | Case studies | 5 | 3.5 |
| | | PR programs | 5 | 3.5 |
| 5. | | PR principles | 5 | 3.5 |
| | | PR programs | 5 | 3.5 |
| | 6-10 YEARS | | | |
| 1. | | Newswriting | 11 | 7.8 |
| 2. | | News editing | 8 | 5.6 |
| 3. | | PR lab | 7 | 4.9 |
| 4. | | PR media | 9 | 6.3 |
| 5. | | Case studies | 6 | 4.2 |
| | 11-15 YEARS | | | |
| 1. | | Newswriting | 13 | 9.2 |
| 2. | | News editing | 9 | 6.3 |
| 3. | | PR principles | 6 | 4.2 |
| 4. | | Case studies | 8 | 5.6 |
| 5. | | PR media | 9 | 6.3 |
| | 15+ YEARS | | | |
| 1. | | Newswriting | 28 | 19.7 |
| 2. | | News editing | 16 | 11.3 |
| 3. | | Newswriting | 13 | 9.2 |
| | | PR principles | 13 | 9.2 |
| 4. | | PR programs | 13 | 9.2 |
| 5. | | PR lab | 15 | 10.6 |

Business Course Rankings and Respondents' Experience

When ranking the top business course, the number of

years of experience a respondent had was not a factor. Marketing was the top choice for all categories of experience. Management was the second most preferred course. Again, accounting was the last choice. Table XIX cross references practitioners' rankings of business courses by their experience.

TABLE XXIII

RANKING OF BUSINESS COURSES BY RESPONDENTS' EXPERIENCE

| Ranking | Experience | Course | N | Percent |
|---|---|---|---|---|
| | 0-5 YEARS | | | |
| 1. | | Marketing | 17 | 12.0 |
| 2. | | Management | 14 | 9.9 |
| 3. | | Finance | 11 | 7.8 |
| 4. | | Economics | 8 | 5.6 |
| | | Finance | 8 | 5.6 |
| 5. | | Accounting | 13 | 9.2 |
| | 6-10 YEARS | | | |
| 1. | | Marketing | 20 | 14.1 |
| 2. | | Management | 15 | 10.6 |
| 3. | | Economics | 8 | 5.6 |
| 4. | | Finance | 10 | 7.0 |
| 5. | | Accounting | 11 | 7.8 |
| | 11-15 YEARS | | | |
| 1. | | Marketing | 18 | 12.7 |
| 2. | | Management | 14 | 9.9 |
| 3. | | Finance | 9 | 6.3 |
| 4. | | Economics | 9 | 6.3 |
| 5. | | Accounting | 14 | 9.9 |
| | 15+ YEARS | | | |
| 1. | | Marketing | 24 | 16.9 |
| 2. | | Management | 26 | 18.3 |
| 3. | | Economics | 17 | 12.0 |
| | | Finance | 17 | 12.0 |
| 4. | | Finance | 28 | 19.7 |
| 5. | | Accounting | 38 | 26.8 |

## Extra-Curricular Activities Rankings and Respondents' Experience

When ranking the top extra-curricular activities, the number of years of experience a respondent had was not a factor. An internship with a public relations organization was the top choice for all categories of experience except for those with 6-10 years of experience, which ranked it as second. Table XX cross references practitioners' rankings of extra-curricular activities by by their experience.

TABLE XXIV

RANKING OF EXTRA-CURRICULAR ACTIVITIES BY RESPONDENTS' EXPERIENCE

| Ranking | Experience | Activity | N | Percent |
|---|---|---|---|---|
| | 0-5 YEARS | | | |
| 1. | | PR intern | 13 | 9.2 |
| 2. | | Volunteer | 10 | 7.0 |
| 3. | | Volunteer | 10 | 7.0 |
| 4. | | PRSSA member | 12 | 8.5 |
| 5. | | Non-PR work | 9 | 6.3 |
| | | Scholarships/grants | 9 | 6.3 |
| | 6-10 YEARS | | | |
| 1. | | PR internship | 18 | 12.7 |
| 2. | | Reporter | 9 | 6.3 |
| 3. | | Volunteer | 10 | 7.0 |
| 4. | | Non-PR work | 7 | 4.9 |
| | | Volunteer | 7 | 4.9 |
| 5. | | Non-PR work | 9 | 6.3 |
| | | PRSSA member | 9 | 6.3 |
| | 11-15 YEARS | | | |
| 1. | | Reporter | 13 | 9.1 |
| 2. | | PR internship | 12 | 8.5 |
| 3. | | PRSSA member | 7 | 4.9 |
| | | Volunteer | 7 | 4.9 |
| 4. | | PRSSA member | 7 | 4.9 |
| 5. | | Scholarships/grants | 11 | 7.8 |

TABLE XXIV (Continued)

| | | | |
|---|---|---|---|
| 15+ YEARS | | | |
| 1. | PR internship | 29 | 20.4 |
| 2. | Volunteer | 21 | 14.8 |
| 3. | Reporter | 20 | 14.1 |
| 4. | PRSSA member | 16 | 11.3 |
| 5. | PRSSA member | 20 | 14.1 |

# CHAPTER V

# SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## General

### The Need for this Study

The Department of Labor has called public relations one of the most popular professions in the United States. By 1995, the Department estimates there will be over 125,000 practicing public relations specialists. Projections by the Public Relations Society of America have put the current figure of public relations specialists at 125,000 and the Society expects the field to grow to 150,000 or more over the next decade.

Public relations has never been an easy field to enter, especially right out of college. Corporations and agencies need entry-level employees, yet often expect such employees to be trained professionals, ready to contribute to their organization from day one. Employers would rather not have to spend precious time and money to train a public relations major fresh out of school. Such a burden undermines the educational system, and raises questions about the validity of a public relations

education program in the eyes of employers.

This study concentrated on those areas of skill/knowledge preferred and recommended by public relations employers. This study should benefit not only the undergraduate public relations student in helping to meet the demands for an employable applicant set forth by employers, but also the public relations educator as a curriculum guide.

Specifically, this study attempted to benefit those educators and students in the specified five-state region by giving them a sequence of skills/knowledge preferred by public relations practitioners in the same region. In addition to helping educators and students, this study gave employers the opportunity to share their views on what they expect of an entry-level applicant as well as a forum to voice their grievances against public relations education in hopes of bettering the quality of its graduates.

## Summary of Study

### The Participants

A mailed questionnaire was used to elicit responses from 200 Public Relations Society of America members in Arkansas, Colorado, Kansas, Missouri, New Mexico, Oklahoma, and Texas. Those members listed as professors, retired, or associate members were excluded from the

study. Participants were randomly drawn using a table of random numbers. The response rate for this study was 71 percent.

Of the respondents, almost one-third (32 percent) categorized themselves as corporate public relations professionals. Those who indicated that they worked for a public relations agency constituted 26 percent of the respondents. Other respondents indicated that they worked in non-profit (15 percent), education and other (9 percent each), business (5 percent), and government (4 percent).

Almost half of the respondents surveyed (44 percent) had earned a degree in print/broadcast journalism. The number of respondents who indicated they had earned a degree in the Other category was unexpectedly high (26 percent). Of those respondents in the Other category, almost half (43 percent) earned a degree in English. A public relations degree was the third most common degree earned among participants, with business ranked forth.

Of the respondents, 46 percent said they had over 15 years of experience, 19 percent indicated they had between six and ten years of experience, 18 percent indicated they had between 11 and 15 years of experience, and 17 percent indicated they had between zero and five years of experience.

The Questionnaire

The questionnaire consisted of six core questions asking participants to rank and rate the importance of courses and activities in three areas: (1) public relations courses, (2) business courses, (3) extra-curricular activities.

In addition to the rating of individual courses and activities, employers were also asked to rate the following when considering an applicant:

1.) The importance of an applicant's overall grade point average.

2.) The importance of an applicant's field-of-study grade point average.

3.) The importance of taking business courses or a minor in business.

4.) The overall usefulness or effectiveness of a college public relations degree (PRSA accredited) once in the real world.

Practitioners were asked to indicate the type of public relations organization they worked for as well as their educational background and years of experience in the public relations field. Practitioners were also asked whether or not their organization gives applicants an entrance exam to determine writing ability. The job title of the person responsible for hiring was also asked. A response rate of 71 percent was attained.

Objectives

The main objective of this study was to determine which skills practitioners viewed as important for the undergraduate public relations major and to develop a list of the top course preferences of practitioners in the specified region. Another objective of this study was to determine which extra-curricular activities practitioners saw as important to augment course work.

## Discussion of Findings

### Preferred Public Relations Courses

Practitioners in this study, as well as in others, ranked newswriting as the top public relations course. The ability to effectively communicate is the number one skill employers look for in an undergraduate.

News editing was the second most preferred course for the public relations student. Judging from the results, practitioners feel the ability to write well must be coupled with a firm understanding of what is newsworthy and what is fluff. It is no longer enough to get a press release printed, the information given must be of relevance to the intended audience.

A public relations internship was ranked as the top choice for both the third and fifth highest ranked course. Practitioners saw the need for students to gain hands-on

experience as vital. Practitioners want students with practical work experience in addition to a strong theoretical background. If, in analyzing the data, the courses which had been previously ranked had been eliminated from consideration, then the fifth highest ranked course would have been a tie between Principles of Public Relations and Visual Communications.

Case Studies in Public Relations, Public Relations Media, and Public Relations Programs all tied for the fourth most preferred course. This emphasized the need for training in all aspects of public relations, from the inception of an idea or the identification of a problem, to the evaluation of the effectiveness of a program once administered.

Preferred Business Courses

Marketing was the overwhelming choice as the top business course for the public relations major. Public relations practitioners are no longer simply the vocal chords for a business. Public relations is now seen as an integral aspect of the entire marketing and management process.

Today, public relations must be able to justify itself and its efforts to upper management. In order to do so, practitioners must speak on managements' level, using their mind-set and concepts. Effective

communication entails more than succinct writing. To be effective, practitioners must be able to understand the management by objectives mentality and then devise a plan with which to disseminate the intended message to the targeted audience.

With this in mind, it should come as no surprise that management was chosen as the second most preferred business course. In fact, this study duplicated the preferences for business courses found in both The Design for Undergraduate Public Relations Education (1987) and the Fitzpatrick study (1982).

Preferred Extra-Curricular Activities

An internship was also chosen as the top preference for the listed extra-curricular activities. This preference, and the second choice, volunteer work with a public relations organization, again stresses the practitioners' desire for practical experience.

Although statistical analysis did not accurately reflect the rankings, practitioners saw the experience as a reporter to be an important extra-curricular activity for the budding public relations practitioner. Experience as a reporter was ranked as second or third behind the most preferred activity in each ranking category. If, in analyzing the data, the activities which had been previously mentioned had been eliminated from

consideration, the experience as a reporter would have been ranked as the third most preferred activity.

Practitioners were less than enthusiastic about student participation in Public Relations Student Society of America, non-public relations work, and the attainment of grants, scholarships and awards.

Practitioners felt not only the course content to be important, but also student performance. The importance of a student's grade point was rated high.

A total of 58 percent said their organization did not require applicants to take a writing exam. Forty-Two percent said their organization did require applicants to take a writing exam.

## Conclusions

The results of this study were similar to those found in previous studies. Practitioners in this study indicated that fundamental newswriting skills should constitute the backbone of public relations training. In similar studies conducted by Cooper (1979), Bobo (1980), Fitzpatrick (1982), and O'Brien and Shelly (1983), all four found that the most preferred public relations course was newswriting.

News editing was seen as the second most preferred public relations course. This ranking came as a surprise when compared to other studies. In most previous studies,

editing skills were ranked as inferior to other more advanced aspects of public relations such as the development, execution and evaluation of programs. Perhaps this is an indication of the importance of not only a clear writing style, but also a sound sense of what constitutes news.

In this study, as with others, a public relations internship was also highly rated. While the Public Relations Society of America has made progress in promoting its Pro-Am (professional-amateur) program to accredited schools, allowing students a chance to intern with a professional, problems with demographics, availability, economics, and logistics can often hinder the successful functioning of an internship program. Until such problems are solved, undergraduates with internship experience may be the wish that goes unfulfilled for public relations employers.

Analysis and criticism of past public relations cases, the development and application of public relations programs, and experience in designing media messages were all seen as important aspects in public relations for the undergraduate public relations student to have been exposed to.

Both The Design for Undergraduate Public Relations Education (1987) and Fitzpatrick (1982) found marketing as the most important business course for the undergraduate

public relations student. In fact, the ranking of recommended business courses in the above studies exactly mirrored the business course rankings found in this study.

The rankings of extra-curricular activities were roughly as expected. It was anticipated that any prior public relations experience, be it an internship or volunteer work, would be at the top of the list. What was surprising was the seemingly ambivalent attitude practitioners had toward the importance of participation in Public Relations Student Society of America, the awarding of scholarships and grants, and work experience not directly related to public relations.

While by no means a completely accurate assumption, student performance in class is often used as an indicator to forecast how well a student will do in the work force. With this in mind, it is understandable why the importance of a student's grade point average was rated high, as was the perceived importance of business courses for the public relations student. From the ratings, it can be assumed that practitioners were more interested in course content and performance in public relations courses than in the attainment of a public relations degree.

## Recommendations to Students and Educators

### Students

Curriculum advice for students based on

practitioners' views in the region specified can be summarized in the following condensed recommendations. Practitioners recommended that the aspiring public relations student should:

1. Develop a clear, concise writing style, placing equal importance on editing and news judgment skills,

2. Gain practical public relations experience through an internship or a job working for a public relations organization, even if as a volunteer,

3. Learn about the principles of marketing and business management and how such principles apply to the public relations practitioner, and if possible, minor in business,

4. Work as a reporter to enhance writing skills and to gain an inside view of how the media works and thinks.

Educators

Curriculum advice for educators based on practitioners' views in the region specified can be summarized in the following condensed recommendations. Practitioners recommended that the public relations educator should:

1. Be aware that well developed writing skills are the single most important tool a public relations student can bring into the marketplace. Of near equal importance is a sound knowledge of editing and news judgment skills,

2. Try to overcome problems associated with internship programs and to develop ways for students to gain practical experience,

3. Understand the importance of business acumen for students, and stress the need for marketing

and management skills as they pertain to the realm of public relations,

4. Stress practical skills over theoretical concepts, encourage any activity which will give the student practical experience (i.e., reporter, speech writer, writing contests, etc.).

## Recommendations for Future Study

While this study sought to determine those courses preferred by practitioners in public relations, business, and extra-curricular activities, it did not seek a comprehensive list of practitioner preferences of the top courses and activities in all combined areas. Such a study would allow the public relations student and educator alike to determine which courses are most important to future employers and how the student can better market himself.

This study excluded certain Public Relations Society of America members, namely those with less than two years of membership in Public Relations Society of America (including those with less than two to three years of experience since graduating), those members practicing in states other than the specified seven-state region, and those members who were listed as educators or retired practitioners. A similar study could be given to any or all of these excluded groups to compare their responses with those of the participants in this study.

While this study asked for practitioners' rankings

and ratings of specific courses, it did not answer the question of whether a public relations sequence meets the practical needs of practitioners. Such a study could solicit input from practitioners as to how to better the training of public relations undergraduates.

The focus of this study was on practitioners' views of undergraduate public relations education. A similar study could be conducted assessing practitioners' views of graduate level public relations education.

The public relations profession is ever-changing, as are the demands placed on public relations education. The Design for Undergraduate Public Relations Education was conducted in 1987. A study similar to the Commission's report on Undergraduate Public Relations Education could be conducted to update to the 1987 study and chart the changing course of public relations education.

## Conclusion to this Study

For the undergraduate public relations student entering today's workforce, simply knowing the theoretical concepts of what public relations is and does is no longer enough. The aspiring practitioner must be able to put theory into motion. He must know how to administer a public relations program from its inception to its conclusion, including recommendations and evaluation.

Not only is the aspiring student expected to know how

this is done and preferrably have had first-hand experience in its execution, but it must be well written and edited with practical implications for business inherent in its format.

From the results obtained in this study, the public relations practitioner wants a graduate to be short on theory and long on practical hands-on experience. Writing and editing skills should be well developed, as well as a basic knowledge of marketing and management techniques.

The hiring practitioner prefers a student with real world experience in the field of public relations, yet internships are unfortunately too few and far between. The prudent public relations student would be well advised to seek practical public relations experience anywhere he can.

Opportunities for gaining experience exist in, but are not limited to, departments or organizations such as the university student activities department, the local chamber of commerce, and various local and national non-profit organizations. Most organizations would welcome volunteer help provided the student is dependable and serious about gaining practical experience, rather than just looking for an activity to put on a resume.

Another source of valuable experience is the university or local newspaper. As the results from this study indicate, practitioners want applicants to have well

developed writing skills. Reporting for the university or community will not only allow the student to fine tune his writing skills, but will also give the student an idea of how the media operates and what is considered to be newsworthy.

The public relations student should not neglect the business aspect inherent in public relations, for the business of business is business. Business courses should constitute a large percentage of the student's curricular electives.

In short, the public relations practitioner wants an entry-level employee to have just enough theory to provide a basic understanding of the principles of business and public relations, and enough experience to be useful.

## ENDNOTES

[1] Allen H. Center and Scott M. Cutlip, Effective Public Relations (revised 5th ed., Englewood Cliffs, 1982), pp. 591-593.

[2] Ibid.

[3] Ibid.

[4] Commission on Public Relations Education, A Design for Public Relations Education (a study co-sponsored by the Public Relations of the Association for Education in Journalism and Mass Communications and the Educators Section of Public Relations of America. 1987), pp. 1.

[5] Ibid.

[6] Ibid., p. 3.

[7] Ibid., p. 20.

[8] A. Scott and S. Barker-Benfield, "What the Professionals Want," Forum (Fall 1971), p.8-11.

[9] Larry Marshall, "The New Breed of Public Relations Executive," Public Relations Journal (July 1980), p. 12.

[10] John D. Simpkins, "Theory, Strategy Get Priority" Journalism Educator (July 1976), p. 53.

11 Commission on Public Relations Education, A Design for Public Relations Education (a study co-sponsored by the Public Relations of the Association for Education in Journalism and Mass Communications and the Educators Section of Public Relations of America. 1987), p. 5.

12 Ibid., p. 5.

13 Gay Wakefield and Laura Perkins-Cottone, "Knowledge and Skills Required by Public Relations Employers," Public Relations Review (Fall 1987) p. 25.

14 Barbara J. Cooper, "Attitudes Toward Public Relations Education: A Survey of Southern California Public Relations Practitioners" (unpub. M.S. thesis, California State University, 1979).

15 Kathy R. Fitzpatrick, "Training of Public Relations Practitioners" (unpub. M.S. thesis, West Virginia University, 1982).

16 Gary O'Brien and Michael B. Shelly, "PRSA, IABC Members Agree on Top Courses" Journalism Educator (Spring 1983), p. 20.

17 "The Corporate Image: PR to the Rescue," Business Week (January 22, 1979), p. 54.

18 Ibid., p. 54.

19 Commission on Public Relations Education, A Design for Public Relations Education (a study co-sponsored by the Public Relations of the Association for Education in Journalism and Mass Communications and the Educators Section of Public Relations of America. 1987), p. 20.

20 Ibid., p. 8.

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22 Frank B. Kapula and T. Harell Allen, "Future Directions in Public Relations Education" Public Relations Review (Summer 1982), p. 31.

23 Bill Baxter, "Business Courses Vital, Executives Advise PR Majors" Journalism Educator (July 1980), p. 43.

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25 Scott Lee Bobo, "The Efficacy of Public Relations Education: What the Texas Public Relations Professional Perceives" (unpub. M.S. thesis, University of Texas, Austin, 1980).

26 Ibid.

27 Ibid.

28 Barbara J. Cooper, "Attitudes Toward Public Relations Education: A Survey of Southern California Public Relations Practitioners" (unpub. M.S. thesis, California State University, 1979).

29 Charles A. Labotka, "An Analysis of Graduate's Perceptions of Public Relations Education at Northern Illinios University Between the Years 1968-1975." (unpub. M.S. thesis, Norhtern Illinios University, 1977).

30 Scott Lee Bobo, "The Efficacy of Public Relations Education: What the Texas Public Relations Professional Perceives" (unpub. M.S. thesis, University of Texas, 1980).

31 Frank B. Kapula and T. Harell Allen, "Future Directions in Public Relations Education" Public Relations Review (Summer 1982), p. 37.

32 Kathy R. Fitzpatrick, "Training of Public Relations Practitioners" (unpub. M.S. thesis, West Virginia University, 1982).

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# APPENDIXES

# APPENDIX A

## COURSE DESCRIPTIONS

## PUBLIC RELATIONS COURSE DESCRIPTIONS

CASE STUDIES IN PUBLIC RELATIONS - Public relations publications planning, problem solving, management techniques, policies and case study analysis.

MASS COMMUNICATION LAW - Study of mass communication law and ethics, FCC regulations and copyright/trademark restrictions.

NEWS WRITING - Fundamentals of newsgathering, reporting and other information gathering techniques in the mass media.

NEWS EDITING - Developing basic news judgment, copy editing, headline writing, stylebook usage and photo editing.

PRINCIPLES OF PUBLIC RELATIONS - Basic concepts, techniques and practice of public relations as a management function in business, industry, government, education, and nonprofit organizations.

PUBLIC RELATIONS INTERNSHIP - Practical public relations experience beyond the classroom for students planning to enter the field of public relations.

PUBLIC RELATIONS MEDIA - Practice in writing, editing and designing materials to be used for news and feature articles, pamphlets, speech ghostwriting and audio-visual presentations, bill inserts, displays, and annual reports.

PUBLIC RELATIONS PROGRAMS - Development and application of public relations programs from the identification of the problem to the execution of the program and evaluation.

VISUAL COMMUNICATION - Principles, techniques and mechanics of photographs, charts, graphs and other nonverbal communication in mass media.

## BUSINESS COURSE DESCRIPTIONS

ACCOUNTING - Principles of managerial accounting, planning and control of sales and costs as well as analysis.

ECONOMICS - Elementary principles of price theory and national income theory developed with an emphasis on analyzing economic issues and for recommending economic policy.

FINANCE - Operational and strategic principles of finance including allocation of funds, asset management, financial information systems, financial structure and analysis.

MANAGEMENT - Decision making as applied to management systems, organizations, and interpersonal relationships.

MARKETING - Consumer behavior, marketing institutions, competition and the law.

# APPENDIX B

# PILOT STUDY COVER LETTER

Dear Public Relations Society of America Member:

It has been said that a profession has come of age when it concerns itself with education for that profession. This is an accurate description of the public relations profession today.

The enclosed survey is part of my thesis for the Master's degree in mass communications at Oklahoma State University. The intent of this survey is to determine what skills the public relations practitioner feels are necessary for an undergraduate public relations major to have upon graduation from a four-year Public Relations Society of America accredited program of study.

You have been randomly selected to analyze and critique the final draft in hopes to better the clarity and intent of my study. Your cooperation in completing the questionnaire and any additional comments you may have will be greatly appreciated.

Sincerely,

David Blohm
Graduate student
Mass Communications
Oklahoma State
University

If you have any questions regarding this study or would like more information please contact me. My number is (405) 743-4504. Or if you would prefer to write, my address is:

David Blohm
201 South Burdick
Stillwater, OK 74074.

The purpose of this study can be confirmed by contacting:
Dr. Charles Fleming - Professor
Oklahoma State University
(405) 744-6354

# APPENDIX C

# QUESTIONNAIRE

# Public Relations Areas of Skill/Knowledge Deemed Important by Public Relations Practitioners

## Questionnaire

GENERAL INSTRUCTIONS: Please answer the following questions concerning undergraduate public relations education according to the instructions given below. Included is a summary of the subject matter for each of the listed courses taught in each of the listed courses.

If you have any questions/comments, please contact me at:

David Blohm
201 S. Burdick
Stillwater, OK 74074
(405) 743-4504

1. RANK NUMERICALLY the TOP FIVE public relations courses listed below that you feel are important for an undergraduate public relations student to have taken.

For example: If you feel the course MASS COMMUNICATION LAW is the most important course listed, place a "1" beside that course offering. If you feel VISUAL COMMUNICATION is the fifth most important course listed, place a "5" beside that course offering. Please rank only five courses. See the attached course descriptions.

_____ CASE STUDIES IN PUBLIC RELATIONS
_____ MASS COMMUNICATION LAW
_____ NEWS EDITING
_____ NEWS WRITING
_____ PRINCIPLES OF PUBLIC RELATIONS
_____ PUBLIC RELATIONS LABORATORY/INTERNSHIP
_____ PUBLIC RELATIONS MEDIA
_____ PUBLIC RELATIONS PROGRAMS
_____ VISUAL COMMUNICATION

Please go to next page

2. RANK NUMERICALLY the following business courses listed below that you feel are important for an undergraduate public relations student to have taken.

For example: If you feel the course ACCOUNTING is the most important course listed, place a "1" beside that course offering. If you feel ECONOMICS is the fifth most important course listed, place a "5" beside that course offering. Please rank only five courses. See the attached course descriptions.

_____ ACCOUNTING
_____ ECONOMICS
_____ FINANCE
_____ MANAGEMENT
_____ MARKETING

3. RANK NUMERICALLY the TOP FIVE extra-curricular activities listed below that you feel are important for an undergraduate public relations student to have participated in.

For example: If you feel the activity PUBLIC RELATIONS INTERNSHIP is the most important activity listed, place a "1" beside that activity. If you feel the activity PUBLIC RELATIONS STUDENT SOCIETY OF AMERICA MEMBER is the fifth most important activity listed, place a "5" beside that activity. Please rank only five activities. See the attached course descriptions.

_____ PUBLIC RELATIONS INTERNSHIP-not for course credit.
_____ NON-PUBLIC RELATIONS RELATED WORK.
_____ PUBLIC RELATIONS STUDENT SOCIETY OF AMERICA MEMBER.
_____ REPORTER FOR SCHOOL PAPER, YEARBOOK OR RELATED EXPERIENCE.
_____ SCHOLARSHIPS, GRANTS, AWARDS (honor roll, etc.).
_____ VOLUNTEER WORK WITH A PUBLIC RELATIONS RELATED ORGANIZATION.

Please go to next page

4. Please rate the importance of each of the following PUBLIC RELATIONS COURSES by placing an "X" along the continuum.

For example: If you feel the course NEWS EDITING is of neutral importance, place an "X" in the middle blank.

| Not Important | | | | | Very Important | |
|---|---|---|---|---|---|---|
| | | | | | | CASE STUDIES IN PUBLIC RELATIONS |
| | | | | | | MASS COMMUNICATION LAW |
| | | | | | | NEWS EDITING |
| | | | | | | NEWS WRITING |
| | | | | | | PRINCIPLES OF PUBLIC RELATIONS |
| | | | | | | PUBLIC RELATIONS LAB/INTERNSHIP |
| | | | | | | PUBLIC RELATIONS MEDIA |
| | | | | | | PUBLIC RELATIONS PROGRAMS |
| | | | | | | VISUAL COMMUNICATION |

5. Please rate the importance of each of the following BUSINESS COURSES by placing an "X" along the continuum.

For example: If you feel the course ACCOUNTING is of neutral importance, place an "X" in the middle blank.

| Not Important | | | | | Very Important | |
|---|---|---|---|---|---|---|
| | | | | | | ACCOUNTING |
| | | | | | | ECONOMICS |
| | | | | | | FINANCE |
| | | | | | | MANAGEMENT |
| | | | | | | MARKETING |

Please go to next page

6. Please rate the importance of each of the following EXTRA-CURRICULAR ACTIVITIES by placing an "X" along the continuum.

For example: If you feel the activity PUBLIC RELATIONS RELATED WORK is of neutral importance, place an "X" in the middle blank.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Not Important | __ | __ | __ | __ | __ | Very Important | PUBLIC RELATIONS INTERNSHIP-not for course credit. |
| | __ | __ | __ | __ | __ | | NON-PUBLIC RELATIONS RELATED WORK. |
| | __ | __ | __ | __ | __ | | PUBLIC RELATIONS STUDENT SOCIETY OF AMERICA MEMBER. |
| | __ | __ | __ | __ | __ | | REPORTER FOR SCHOOL PAPER, YEARBOOK OR RELATED EXPERIENCE. |
| | __ | __ | __ | __ | __ | | SCHOLARSHIPS, GRANTS, AWARDS (honor roll, etc.). |
| | __ | __ | __ | __ | __ | | VOLUNTEER WORK WITH A PUBLIC RELATIONS RELATED ORGANIZATION. |

Please go to next page

7. Please rate the importance of each of the following questions by placing an "X" along the continuum.

For example: If you feel the importance of an applicant's overall grade point average is of neutral importance, place an "X" in the middle blank.

| Not Important | | | | | Very Important | |
|---|---|---|---|---|---|---|
| | | | | | | The importance of an applicant's overall grade point average. |
| | | | | | | The importance of an applicant's grade point average in public relations courses. |
| | | | | | | The importance of taking business courses or a minor in business. |
| | | | | | | The overall usefulness or effectiveness of a college public relations degree (PRSSA accredited) once in the "real world." |

8. Please check the type of public relations organization you work for.

_____ Agency
_____ Non-profit
_____ Government
_____ Corporate
_____ Business
_____ Education
_____ Other (specify) _____

Please go to next page

9. Your educational background.

_____ degree/emphasis in public relations.
_____ degree/emphasis in print/broadcast journalism.
_____ degree/emphasis in business.
_____ Other (specify) _____

10. Years of public relations experience.

_____ 0-5
_____ 6-10
_____ 11-15
_____ 15+

11. Does your organization require job applicants to take a written exam to determine writing ability?

_____ YES _____ NO

12. What is the job title of the person responsible for hiring public relations personnel?

_____

_____

13. Finally, if you were to give one piece of advice to a public relations student entering the field, what would it be?

_____

_____

_____

Please feel free to add any additional comments below:

# APPENDIX D

# INITIAL AND FOLLOW-UP COVER LETTERS

Dear *Public Relations Society of America* member,

A PENNY FOR YOUR THOUGHTS?

Much debate surrounds the issue of how to best prepare undergraduate public relations students for a career in public relations.

As a graduate student at Oklahoma State University, I'm conducting a study of Public Relations Society of America members in the Southwest. The purpose of this study is to determine what skills you, a public relations employer, feel are necessary for an undergraduate public relations student to have upon graduation.

Would you do me a favor?

I hope to shed some light on this subject, but need your input. I would appreciate it if you would please take a few minutes to complete this questionnaire and return it in the enclosed stamped envelope.

You may notice a number on the envelope. The sole purpose of this number is to keep track of responses and help with a follow-up mailing if necessary. All answers to this questionnaire will be held in the strictest of confidence.

While the penny is just a small token of my appreciation, I'll thank you in advance for taking the time to complete this questionnaire. Your cooperation is greatly appreciated.

Sincerely,

David Blohm

If you have any questions regarding this study or would like more information please contact me. My number is (405) 743-4504. Or if you would prefer to write, my address is:
David Blohm
201 South Burdick
Stillwater, OK 74074.

The purpose of this study can be confirmed by contacting:
Dr. Charles Fleming - Professor
Oklahoma State University
(405) 744-6354

Dear *Public Relations Society of America* member,

A few weeks ago I mailed you a letter and questionnaire concerning a study I am conducting. The purpose of my study is to determine how you, a public relations employer, feel about undergraduate public relations education.

Since I have not received your completed questionnaire, I am concerned that my first letter may not have reached you. I have enclosed another questionnaire and ask that you take a few minutes to complete and return it via the enclosed stamped envelope.

As I mentioned in my first letter, I hope to shed some light on this subject but need your input. The success of my study depends on you. While I realize how busy you must be, please take a few moments to complete and return the questionnaire.

If you have already completed and returned the questionnaire, I'll take this oppportunity to thank you again for your time.

Your cooperation is greatly appreciated.

Sincerely,

David Blohm

If you have any questions regarding this study or would like more information, please contact me. My number is (405) 743-4504. Or if you would prefer to write, my address is:

David Blohm
201 South Burdick
Stillwater, OK 74074

The purpose of this study can be confirmed by contacting:
Dr. Charles Fleming - Professor
Oklahoma State University
(405) 744-6354

Dear *Public Relations Society of America* member,

Over the last few weeks I have mailed you two letters asking you to participate in a study I am conducting. The purpose of my study is to determine how you, a public relations employer, feel about undergraduate public relations education.

Since I have not received your completed questionnaire, I am concerned that my first two letters may not have reached you. I have enclosed another questionnaire and ask that you take a few minutes to complete and return it via the enclosed stamped envelope.

As I mentioned in my first two letters, I hope to shed some light on this subject but need your input. The success of my study depends on you. While I realize how busy you must be, please take a few moments to complete and return the questionnaire.

If you have already completed and returned the questionnaire, I'll take this oppportunity to thank you again for your time.

Your cooperation is greatly appreciated.

Sincerely,

David Blohm

If you have any questions regarding this study or would like more information, please contact me. My number is (405) 743-4504. Or if you would prefer to write, my address is:

David Blohm
201 South Burdick
Stillwater, OK 74074

The purpose of this study can be confirmed by contacting:
Dr. Charles Fleming - Professor
Oklahoma State University
(405) 744-6354

# VITA

David W. Blohm

Candidate for the Degree of

Master of Science

Thesis: A SURVEY OF EMPLOYER RATINGS OF COURSES OFFERED AT MAJOR UNIVERSITIES IN ARKANSAS, COLORADO, KANSAS, MISSOURI, NEW MEXICO, OKLAHOMA, AND TEXAS IN THE P.R. DEGREE SEQUENCE AND OF CERTAIN NON-ACADEMIC ACTIVITIES.

Major Field: Mass Communications

Biographical:

Personal Data: Born in Tulsa, Oklahoma, November 29, 1963, the son of Glenna Owens and Raymond William Blohm.

Education: Graduated from Bishop Kelley High School, Tulsa, in May 1982; received Bachelor of Science Degree in Psychology from Oklahoma State University at Stillwater in May 1987; completed requirements for the Master of Science degree at Oklahoma State University in December, 1989.

Professional Experience: Assistant News Editor, The Daily O'Collegian, Oklahoma State University, August to December, 1987; Member of Kappa Tau Alpha, Honorary Journalism Society.